ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XLVI. No. 13.

TABLE OF CONTENTS:

ENGINEERING NEWS OF THE WEEK..... 209
The New 3,100,000-Bushel Grain Elevator for the Great Northern Ry., at West Superior, Wis. (with two-page plate and other illustrations)..... 210
A Water-Cooled Blast Furnace Bosh (illustrated)... 212
Some Peculiar Wrecks of Steel Cars (illustrated)... 213
The Protection of Ferric Structures from Corrosion. 215
A Proposed Concrete Three-Hinged Arch Bridge Near Oviedo, Spain (illustrated)..... 215
Tunnel Through Sand Under the River Spree at Berlin (illustrated)..... 218
A Centrifugal Separator for Shavings and Dust (illustrated)..... 219
Civil Service Examination for Superintendent of Water-Works at Columbus, O..... 219
Irrigation in the Nile Valley and Its Future (illustrated)..... 219
Water-Tight Caisson Foundations for the New York Stock Exchange (illustrated)..... 222
Annual Convention of the New England Water-Works Association..... 224
EDITORIAL NOTES..... 216
Standard Specifications for Cast-Iron Water Pipe—Protecting Surface Water Supplies from Pollution—Two Recent Rear Collisions and Their Lessons—The Need for a National Official Investigation of Railway Accidents.
EDITORIAL:
Some Thoughts Concerning Changes in Bridge Design..... 216
LETTERS TO THE EDITOR..... 218
An Indexing System for a City Engineer's Office—Stresses on Dams Due to Impact—Notes and Queries.

THE SOUDAN MILITARY RAILWAYS were described in a paper read by Major C. B. Macauley, of the Royal Engineers, before the recent International Engineering Congress. They consist of two lines, one running from Wadi Halfa across the Nubian desert and thence to Khartoum, a distance of 576 miles, and the other running southeast from Wadi Halfa, following the general course of the Nile, to Kerma, 263 miles. Nearly 50% of these lines is in a barren desert and every train leaving one terminus for the other has to haul five tank cars carrying 9,500 gallons of water, in addition to the supply on the tender. The Nubian desert is a flat sandy plain. There is one tangent 45 miles in length without any cuttings or embankments on it worthy the name. The only vegetation consist of rare speciments of the Sunt tree, a species of acacia, and although it is found at two places in the desert where water was found by sinking wells, it is also found at other places where no water was found in borings 200 ft. deep. The total distance across this desert is 230 miles. The drifting sand causes much difficulty in the operation of the road, as the engine tires and all working parts of the locomotive wear very rapidly. On the Khartoum line track was laid at the rate of 2,000 to 2,800 yds. per day with a maximum of 5,000 yds. in a day. The track is 3 ft. 6 ins. gage, and is chiefly laid with 50-lb. rails. The ties are of wood except on the section south of the Atbara River, where steel ties have to be used on account of the ravages wrought by white ants. The bridge over the Atbara River, 1,050 ft. in length, built by the Pencoyd Bridge Co., is the only structure of any importance on the entire line. The train service to Khartoum consists of two fast trains weekly each way and a daily mixed train, which carries Government supplies, etc.

A ROYAL TRAIN FOR THE DUKE AND DUCHESS of Cornwall and York, in the tour of the Dominion of Canada, has been prepared by the railway authorities of Canada. There will be three separate trains in the outfit, run in two sections. The first, of nine cars, will have two devoted solely to the use of the royal visitors, and these are described as "a dream of luxury and comfort"; five other coaches will be used by the suite of the Duke and Duchess. A special telephone system has been arranged for this train. Preceding the royal train will be one carrying the detectives and other officers responsible for the safety and comfort of the party; and a following train will transport the horses, carriages and heavier baggage. The combined trains will be in the charge of Mr. W. R. Baker, Assistant to the Second Vice-President of the Canadian Pacific Railway.

ELECTROLYSIS OF GAS PIPES in Hamburg was the subject of a paper submitted to the Engineers' Congress at Glasgow by Dr. Leybold. In Hamburg the water pipes were protected with canvas and boiled tar before laying; but Dr. Leybold said that destruction from electrolysis was more rapid and certain with this coating than without it. The pipes laid in the earth without coating lasted longer, as the earth seemed to absorb some of the electric fluid. When new pipes, canvas-covered and tarred, were laid to replace the old ones, they were found to be destroyed, penetrated with holes, in 7 to 8 months. Dr. Leybold knew of no remedy, except to reduce this return current through the pipes as much as possible by the laying of conducting rails properly connected, or by putting up insulated return transmission cables, leading back to the power house.

A SECOND SERIES OF FIRE TESTS on tile and plaster blocks and metal and plaster combined thin partitions will be conducted at the north side of East 105th St., adjoining the Harlem River in New York city, on Monday, Sept. 30, at 1 p. m.

THE ELECTRIC PLANTS OF ITALY have been recently reported upon by the Minister of Industry and Commerce for the period 1883-1900. This report includes a history of electrical development in Italy and describes each plant separately. The electric station of San Radegonde, at Milan, established in 1883, was the first of this type of any importance executed in Europe. It contained at the start nine dynamos of 200 HP. each, and supplied 1,200 incandescent lamps, says the "Genio Civile." This plant was followed by that of Rome in 1886; Venice, in 1890; Turin, in 1892, etc. The application of electricity to tramways is also reported upon, and the lines of Florence, Milan, Rome, Naples, Livorno, etc., are described. Considerable lengths of railway line in Italy are now operated by electric power.

ELECTROLYTIC PRINTING, by the method proposed by Mr. Friese-Greene, of England, would substitute for printer's ink, an impression resulting from the combination of an electric current and suitable chemicals in the paper. He would use the same presses and type now employed; but with the type connected to the negative pole of some source of electricity, and the pressure rollers connected to the positive. Using nitrate of silver, the inventor figures he could print an 8-page newspaper with the expenditure of 1.134 grs. of silver. Manganese sulphate and nitrate of soda is a cheaper and efficient compound.

THE TRAMWAYS OF BUENOS AYRES are much used by the inhabitants of that city, each resident being credited with 161 trips per year. This is notwithstanding the fact that the system has only 64½ miles of electric roads to 279 miles of horse railway. The central business portion of Buenos Ayres has only two streets without tramways.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision on the New York, New Haven & Hartford R. R., near Avon, Mass., on Aug. 19. Two crowded cars attached to the outward bound Cape Cod express collided with a locomotive attached to a freight train and were hurled down an embankment, killing six persons and injuring about 30 others.

THE ENGLISH TURBINE DESTROYER "COBRA" foundered in the North Sea, on Sept. 19, and 67 lives were lost out of the 79 abroad. The "Cobra" left the Parson Turbine Works, at Newcastle, en route to Portsmouth, on a boiler test, with a heavy gale blowing and the sea very rough. The destroyer struck on the Gudgeon Rocks and broke in two; and one report says that the boiler exploded immediately after striking and she sank immediately. Five boats were launched, but it is believed that all but one were swamped in the heavy sea. The "Cobra" was a sister ship to the destroyer "Viper"; she was fitted with the Parson turbine engines, and in an unofficial trial, about one year ago, she made a record of 37.7 knots, thus slightly beating the record of the "Viper." The "Cobra" cost $350,000. The later accounts deny that the "Cobra" struck a rock and say that she sunk in 27 fathoms of water. It is more probable that she simply broke her back in encountering heavy seas.

THE FALL OF A TANK through the roof and floors of Rothschild & Co.'s department store, in Chicago, on Sept. 19, caused considerable damage to the building and contents, but nobody was hurt owing to the store being closed on account of the funeral of the late President McKinley. The tank was new and partly supported by a party wall, the store occupying a number of old buildings. This wall had already been pierced by openings to connect the different parts of the store, and another opening had just been made, but the iron work to support the wall over the opening had not been put in. The managers of the store claim that a fire or explosion caused by electric wires or gas pipes disturbed by the workmen must have weakened the wall, but the Fire Department considers that the cutting of the wall alone accounts for the accident.

THE SANITARY CONDITION OF HAVANA, under date of Sept. 4, 1901, is reported upon by Major and Surgeon W. C. Gorgas, U.S.A., Chief Sanitary Officer. The population of Havana is 258,888. The August death rate was 22.24 per 1,000, comparing favorably with many of the leading cities of the civilized world, and it is noted that while there were 480 deaths in August, the average for August, since 1889, is 902. There was not a case of smallpox, and only two deaths from yellow fever in August, though the average deaths from this cause since 1889 is 84 for August. In the five months, beginning April 1, 1901, there were only three deaths from yellow fever; though in 1897 there were 603 deaths from this cause in the same period, and 18 in 1899—the least previous number. Dr. Gorgas ascribes these improved conditions to the methods of disinfection adopted by order of the military governor, which has caused the thorough destruction of infected mosquitoes in the neighborhood of the focus of infection.

THE DRAINAGE OF THE ZUIDER ZEE is again proposed in a measure lately presented to the States General of the Netherlands. The plan is to build a dike running from the North Holland coast to the Island of Wieringen and thence to the Frisian coast, and to pump out the water. The plan involves the reclaiming of 114,901 acres in 18 years, and the railway distance between North Holland and Friesland would be reduced 31 miles. Including an indemnity of $1,809,000 paid to the Zuider Zee fishermen, the total estimated cost of reclaiming this land is $38,190,000. It is proposed to call the newly created province Wilhelminaland.

THE EFFECT OF FORESTS ON SNOW and the combined effect of the two on the available water supply of a country are the subject of Bulletin No. 55 of the Agricultural Experiment Station of Fort Collins, Colo. The bulletin was written by Prof. L. G. Carpenter, Director and Irrigation Engineer of the station. The conclusions of the author are as follows:

(1) The mountain streams in the early irrigation season are largely supplied by melting snow.
(2) There is a marked diurnal fluctuation, greater with high water than with low, due to the daily variation in the rate of melting.
(3) The stream at high water may be one-half greater than at low water on the same day.
(4) Cloudy weather in the mountains, protecting the snow from the radiation of the sun, causes the fluctuation to disappear and the flow to decrease.
(5) This decrease is so great that the cloudiness associated with continued rain usually more than counterbalances the gain from the rain.
(6) The loss of snow by evaporation is considerable, especially when exposed to winds.
(7) Snow remains in the timber and in protected spots much longer than where exposed.
(8) This is due not so much to drifting as to shelter from the radiation afforded by the forest cover.
(9) Hence, the greater amount of forest cover the less violent the daily fluctuation, the more uniform the flow throughout the day and throughout the season, and the later the stream maintains its flow.
(10) The loss of the forest cover means more violent fluctuation during the day, greater difficulty in regulating the headgates and keeping a uniform flow in ditches, and hence an additional difficulty in the economic distribution of water. Also, the water runs off sooner; hence the streams drop earlier in the summer, and on account of the lessening of the springs the smaller is the winter flow.
(11) The preservation of the forest is an absolute necessity for the interest of irrigated agriculture.

THE GOOD ROADS CONGRESS, in session at Buffalo, N. Y., during the last week, brought together a number of road experts. Papers were read by Mr. John A. C. Wright, of Rochester, N. Y.; Mr. Chas. W. Ross, of the Mass. Highway Commission; Prof. J. A. Holmes, State Geologist of North Carolina; Hon. A. W. Campbell, Deputy Minister of Public Works, of Ontario, Canada; Prof. Lewis M. Haupt, of the Isthmian Canal Commission; Mr. S. S. Bailey, of Grand Rapids, Mich.; Capt. I. G. Heap, Des Moines, Ia.; Mr. Edward Daniels, of Washington, D. C.; Mr. G. F. Beam, Ontario, and others.

THE TORPEDO-BOATS "Nicholson" and "Porpoise" were both launched from the Lewis Nixon Shipyard, at Elizabethport, N.J., on Sept. 23. The first-named is one of the largest boats of this class built by the government. She is 185 ft. long and 200 tons displacement, and her guaranteed speed is 26 knots. The "Porpoise" is the fourth of the six Holland submarine boats building in this yard. She is 64 ft. 4 ins. long, 11 ft. 9 ins. beam, and is equipped with a 160-HP. gasoline engine for surface running, and a 70-HP. electrical motor for submarine work. She is designed to make 10 and 8 knots respectively with these engines.

THE NEW COAST SURVEY STEAMER "BACHE" was launched, on Sept. 20, from the yard of the Townsend & Downey Shipbuilding & Repair Co., on Shooter's Island. This steamer is 163 ft. long, 27 ft. beam and will draw 8 ft. 2½ ins.; she is fitted with triple-expansion engines, developing 175 HP., Scotch boilers, and is schooner rigged. The "Bache" will be especially equipped for survey work. The designer was Mr. L. B. Friendt.

THE FASTEST RECORD BETWEEN NEW YORK AND Havre was made by the new steamship "La Savoie," of the French Trans-Atlantic Line, which left New York, at Sandy Hook Light, at 11.58 a. m. on Sept. 12, and arrived at Havre at 6 a. m. Sept. 19. The passage was thus made in 6 d. 13 h. 2 m. The same ship made the passage to this port in 6 d. 11 h., the best westbound record.

LIEUT. PEARY WILL AGAIN ATTEMPT TO REACH the North Pole, says Mr. H. L. Bridgman, Secretary of the Peary Arctic Club. Next April, Peary proposes to make another start north, from Cape Hecla, the highest point of land he has discovered in the West, and only 500 miles from the Pole. Lieut. Peary will pass the coming winter at Cape Henschel, and he announces that he has already stored walrus meat and made other preparations sufficient to enable him to start on his exploration trip next spring.

THE NEW 3,100,000-BUSHEL STEEL GRAIN ELEVATOR FOR THE GREAT NORTHERN RY., AT WEST SUPERIOR, WIS.

(With two-page plate.)

The great increase in the capacity and mechanical equipment of grain elevators, combined with the substitution of steel for timber in their construction, have placed these structures among the most important engineering works of modern times. Perhaps one of the best, and certainly one of the latest examples of grain elevator construction, which deserve mention, is the 3,000,000-bushel terminal elevator put in operation at West Superior, Wis., in February of this year. This elevator was built by the Great Northern Ry., and is designed to eclipse in every way the mammoth steel elevator built by the same company at Buffalo, N. Y., in 1897-8 (Eng. News, April 7, 1898), and which surpassed at the time of its completion all previous attempts at fireproof elevator construction. Briefly described, the new West Superior elevator is 364½ × 124½ ft. in plan, and is 246 ft. high; it will unload from 550 to 600 cars of grain in 24 hours, will deliver on shipboard 300,000 bushels in the same time, will clean 12,200 bushels per hour, and its steel bins have an aggregate storage capacity of 3,100,000 bushels, and number 505. Through the courtesy of the Engineering Department of the Great Northern Ry., we are enabled to present here a description and illustrations of the construction and equipment of this notable structure.

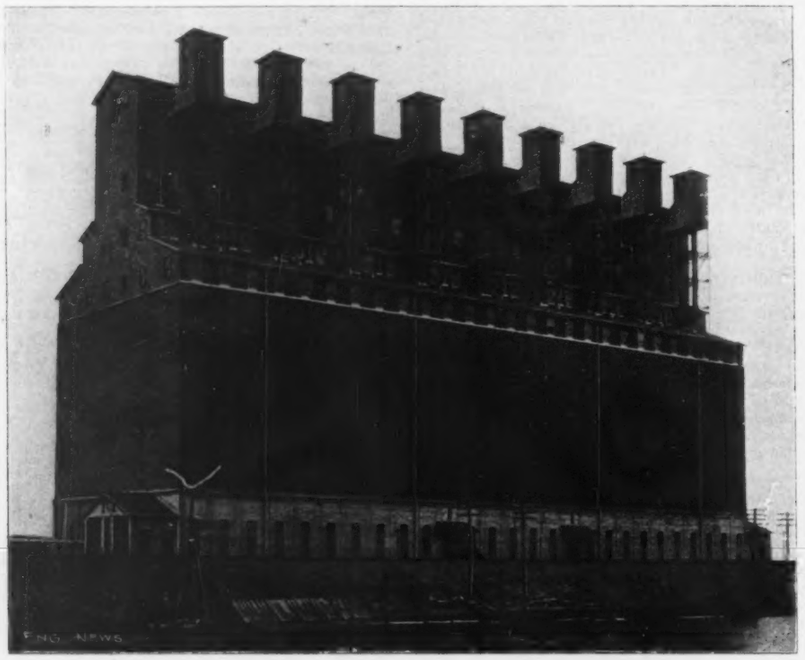


FIG. 1. GENERAL VIEW OF 3,100,000-BUSHEL STEEL GRAIN ELEVATOR FOR THE GREAT NORTHERN RY., AT WEST SUPERIOR, WIS.

John F. Stevens, M. Am. Soc. C. E., Chief Engineer; Max Toltz, M. Am. Soc. C. E., Mechanical Engineer, and A. D. Billinger, Superintendent of Elevators, Great Northern Ry.

GENERAL DESCRIPTION.—In exterior form the new West Superior elevator conforms to usual practice (Figs. 1 and 2). There is a rectangular "house" surmounted by a longitudinal superstructure or "cupola." The house contains a basement floor and a main floor, and, above the main floor, is filled with storage bins. The cupola contains the bin floor, a spout floor, a scale floor, and a machinery floor. On the receiving side of the elevator there rise from the house roof nine towers to form continuations of the receiving legs. The towers and the exterior walls and the floors of the house and cupola are of steel framework construction, and are covered with steel truss roofs. On the opposite side from the receiving legs there are nine shipping legs, and between the two rows of shipping and receiving legs there are nine cleaning legs. The shipping side of the elevator fronts on the dock, and the receiving side connects with the railway tracks of the terminal yard. It will prevent some confusion, perhaps, if we consider the several parts of the structure individually.

FOUNDATIONS.—The elevator structure rests on a pile and grillage foundation. As indicated by Fig. 2, the piles are arranged in groups, one group for each column, and one for each of the nine receiving hoppers. The piles were sunk by water jet, and a 4,200-lb. hammer, through a mixture of sand and clay, to a depth of from 25 ft. to 45 ft., where hardpan was struck. The grillages in each case consisted of two layers of timber. In the case of the three rows of columns on the water front side of the building (Columns A, B and C, Fig. 2), the transverse caps were made continuous over three clusters of piles, and the longitudinal timbers were made continuous over two clusters of piles (A and B, Fig. 1). In all other cases each group of piles and its grillage are a separate structure. The lower timbers of the grillage were 8 × 12-in. white pine timbers, spaced 2½ ft. apart c. to c., while the upper timbers were 6 × 6 ins., laid close together. On top of each grillage was built a pyramidal pedestal of concrete to carry the column base. The concrete used was composed of one part American Portland cement (Medusa brand), 2½ parts clean sharp sand and 5 parts of broken Kettle River sandstone. The maximum pressure allowed on the concrete was 500 lbs. per sq. in., and the maximum load on one pile was 22 tons. A good notion of the foundation construction is obtained by the transverse and the part longitudinal elevations, Fig. 3. These sections also show the receiving hopper construction in some detail.

STEEL FRAMEWORK.—The foundation pedestals carry 280 Z-bar columns, which rise to a height of 42 ft. generally, and carry the girders to which the bottoms of the rectangular bins are attached. The arrangement of these columns in plan is shown by Fig. 4, and in elevation by Fig. 1. Fig. 5 shows the details of a typical interior column. The columns are of the Z-bar type, and rest on cast-iron bases anchorbolted to the concrete pedestals. As will be seen from Fig. 4, a column is placed at each corner of each rectangular bin. These bin corners reinforced continue the columnar structure to the level of the bin floor, where the columns supporting the upper part of the house and the cupola begin, as is clearly shown by Fig. 6. Fig. 6 shows the details of the framing above the bin floor so fully that further description is unnecessary. To the height of the bottoms of the bins the exterior walls are of brick, and above this level they are of corrugated iron.

BINS.—The building contains 505 rectangular bins 85 ft. high, divided as follows:

	Capacity in bushels.
8 Shipping bins, 13 ft. 6 ins. × 27 ft.	24,900
91 Standard bins, 13 ft. 6 ins. × 13 ft. 6 ins.	12,800
54 Large bins, 16 ft. 10½ ins. × 13 ft. 6 ins.	15,900
28 Small bins, 6 ft. 9 ins. × 13 ft. 6 ins.	6,300
324 House and cleaner pockets, 6 ft. 9 ins. × 4½ ft.	2,100

The bins are constructed by means of plates and angles, 17 courses of plates, each 5 ft. high, being used. Starting at the bottom of the bins, the first two courses are 5-16-in., the next four courses ¼-in., and the remaining eleven courses 3-16-in. thick. The horizontal seams of the bin plates are spliced together with splice plates or butt straps. On every second seam, or at an interval of every 10 ft., the lower end of these butt straps is bent out towards the center lines of bin. This construction has been adopted for the purpose of arching the grain and to transfer the pressure directly to the corner angles or columns, thus relieving the pressure on the bin bottom.

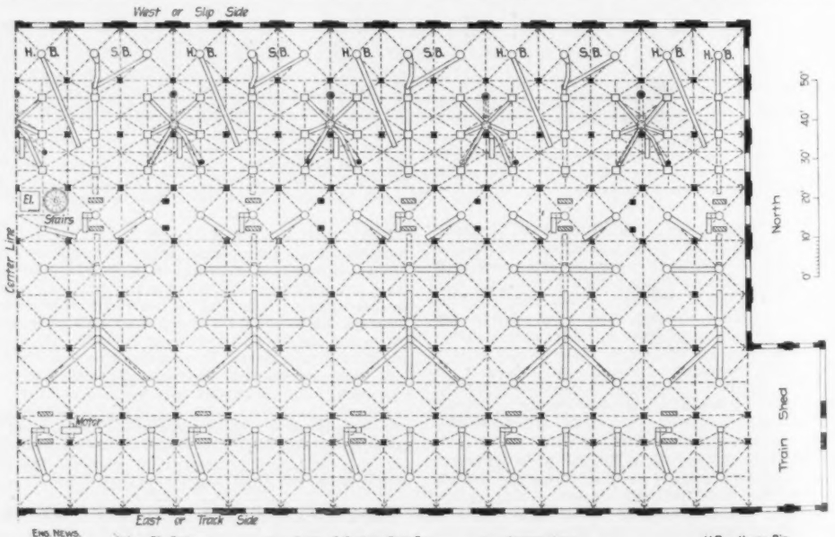


FIG. 4. HALF-PLAN AT MAIN FLOOR.

Fig. 7 is an interior view showing the columns of the main floor and the general appearance of the bin bottoms from below. Fig. 8 shows the

details of the bottom portion of one of the 13½ × 13½-ft. bins. As will be seen, the hopper bottom is a rectangular pyramid terminating in a cone. Fig. 2 shows the arrangement of the bins in elevation, and Fig. 4 shows their arrangement in plan. Above the bins there are four floors, as shown by Fig. 2.

BASEMENT FLOOR.—The principal structural features of the basement floor are the nine receiving hopper pits, into which the grain arriving by railway is discharged for elevation, and the cleaning hoppers. The receiving leg pits are concrete-lined, and into them extend the hopper-shaped boot legs of steel plates. The cleaning leg

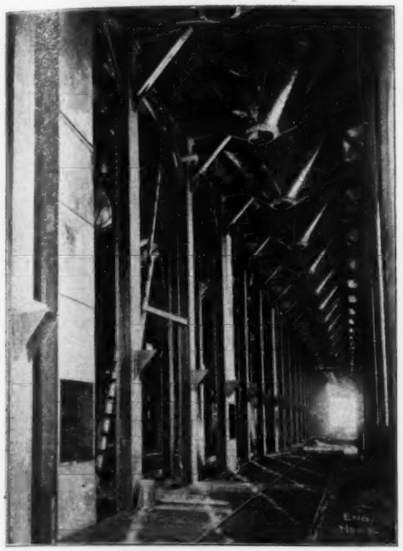


Fig. 7. Interior View on Main Floor, Showing Column and Bin Construction.

hoppers do not project below the floor line. The general construction is clearly indicated by Fig. 1. From the receiving pits the elevator legs extend up through the bins and thence are continued in steel frame towers to the level of the top floor of the cupola. The cleaner legs also reach from the basement to the top floor of the cupola, but are contained within the walls of the main building, and do not require separate towers for their accommodation.

MAIN FLOOR.—The main floor is 11 ft. above the basement floor, and is constructed of concrete over brick arches carried by I-beams. This floor contains the dust-collecting machinery and the car shovels, unloading tracks, etc.; the cleaner leg boots, and the spouting to them are in the basement. Fig. 9 is a representative section through the main floor, and shows quite clearly the arrangement of spouting and of the other principal mechanism. As will be seen, there are two tracks running through the house to a transfer table 600 ft. distant from the elevator. The loaded cars are brought into the house and to the transfer table by a car haul. The 18 receiving or car hoppers are 12 × 35 ft. each, two of them being provided for every receiving leg. The great length of 35 ft. was found necessary to make possible the unloading of 18 cars at the same time, without spotting each car over the hopper. To facilitate this operation the 18 power-shovels are movable, and can be placed opposite door of cars. The empties are distributed by the transfer table to twelve yard tracks, which have a capacity of 160 cars. The arrangement of the spouting and of the cleaning machinery is clearly shown by the drawing, as is also the operation of the car shovels. Details of one of the shovels are shown in Fig. 10. These shovels are unique, and the following description from the specifications will prove interesting in connection with the drawings of Fig. 10.

There are two shovel lines, each containing nine double shovels, or a total of 18 double shovels. One motor is used to drive either line. The motor is equipped with two sheaves, each driving a countershaft, which can be engaged by means of the friction clutch at the driven sheave; on the same countershaft is the line-driving sheave, having four grooves, two ropes driving to the right and two ropes to the left; thereby dividing each line drive into two parts, which have their respective tensions at the ends of the building. Each of the movable shovels consists of a structural iron frame which rolls on the deck beams by means of two wheels and bears at the bottom, against a 6-in. channel by means of a 10-in. roller, the bearing of which reaches around the underside of the channel and serves as guides.

The Clark shovel proper is mounted on two 6-in. channels and is driven by means of bevel gears, which receive their motion from the 48-in. rope sheave which has a 30-in. idler at each side; fastened to the frame are brackets which receive the swing brackets on which the horizontal and vertical 6-in. car sheaves are mounted, so that these sheaves can be swung out of the way, when not in use in order to move the shovel to a desired point. There is a friction collar at the end of the shovel shaft, which by means of the clutch lever, will engage the small drum, and thereby will move the shovel frame along. The angle of this friction between collar and drum is to be made obtuse, so as to clear itself freely and will engage only while the lever is pressed against the drum. There is also a spring, bearing against the end of the drum which serves as a brake, to prevent the drum from paying out more rope than it can keep taut and yet not interfere with the winding up of the rope. The levers of the two drums are connected to insure the throwing out of one friction collar, when the other one is engaged. The ends of the ropes for these drums are fastened to the side of the rail on which the frames ride, an idler leading on to the drum.

The dust-collector system, which is partially shown in elevation by Fig. 9, is unusually elaborate. It gathers the dust from the cleaning machines on the main floor, from the screening conveyor and legs at the basement floor, and from the receiving and screening leg heads and garners, and delivers it to furnace feeders in the boiler-room by means of an elaborate system of piping.

CUPOLA FLOORS.—The cupola contains four floors, as shown by the transverse section Fig. 11. These floors and their equipment, briefly described, are as follows: (1) The bin floor. (2) The spout and conveyor floor, with two 40-in. conveyor belts. (3) The scale floor, containing 18 scale hoppers on 18 Fairbanks' scales. These scale hoppers each hold 1,000 bushels of oats, while the capacity of scales is 120,000 lbs. Above the scale hoppers are 27 garners, of which 18 are scale garners and 9 cleaner garners. The capacity of garners is 25% larger than capacity of scale hoppers. (4) The machinery floor, which contains all the motors which drive the 9 receiving, 9 shipping and 9 cleaner legs. The capacity of the receiving and shipping legs is 12,000 bushels per leg per hour, the capacity of the cleaner legs 3,000 bushels in the same time. The screenings from these machines are discharged on a 20-in. conveyor belt in basement. This belt empties into the boot of a cleaner leg, from where the screenings are elevated and distributed to the proper bins.

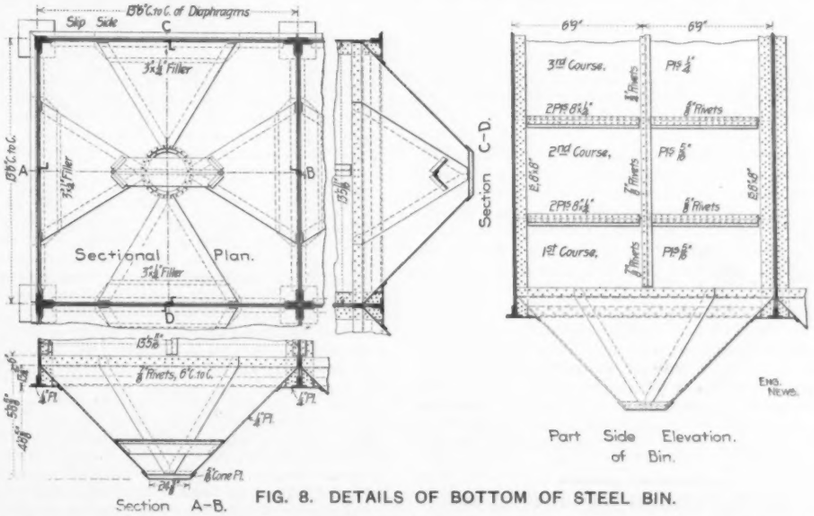


FIG. 8. DETAILS OF BOTTOM OF STEEL BIN.

OPERATION.—Turning now to the operation of the various parts described: When wheat is brought into the elevator in cars, of which nine can be pulled in by a grip cable at one time, it is pushed by the automatic shovels out of the car onto a grating over one of nine receiving hoppers. Running to the bottom of these are endless belts carrying small buckets which scoop up the grain and hoist it to the very top of the house, the upper part of each belt running in one of nine steel towers. Dumped from the belt, the grain is shot into a spout and directed across the top of the building to the garners, from which it falls into scales. It then drops through a swinging turnhead into any one of numberless spouts and is conducted, perhaps to a belt conveyor by which it is handled longitudinally of the building, perhaps by way of another series of turnheads and spouts to its bin. If to be cleaned it falls through the cleaner bin to one of the cleaning machines and passes over the sieves on the main floor, whence it returns again to the top of the house and down into a bin. If to be shipped it is sent a second time to the scales and thence to the shipping bins, which have capacity sufficient to load a ship of 160,000 bushels at one draft. All screenings from the cleaners are directed to a belt in the basement and then collected. All dust is gathered and conveyed to the furnaces in the boiler-house.

OPERATING MACHINERY.—The elevator is electrically-driven throughout, deriving its power from the company's generating station 300 ft. distant. The generators are three-phase machines having a frequency of 60 cycles per second, and delivering current to bus bars in the station at 440 volts. From the station bus bars power is delivered to a distributing panel in the center of elevator. The main feeders consist of nine 800,000 circular mil cables, three being used per terminal. These cables connect to bus bars on elevator panel and from these bars in turn the distribution throughout the house is made by means of six circuits.

The Westinghouse Company's type "C," 400-volt induction motors are used exclusively, and are distributed as follows: Nine 75-HP. special motors located on the machinery floor for driving the receiving legs; nine 75-HP. special motors located on the machinery floor for driving the shipping legs; one 50-HP. standard motor located on the machinery floor for driving a double 50-in. fan; nine 15-HP. standard motors located on the machinery floor for driving the cleaner legs; two 25-HP. standard motors located on the spout floor for driving the conveyor belts; four 50-HP. standard motors located on the main floor for driving the cleaning machinery; one 50-HP. standard motor located on the main floor for driving the power shovels; two 50-HP. standard motors located in the basement for driving the 50-in. double fans; one 35-HP. standard motor located in the basement for driving the single 50-in. fan; one 15-HP. standard motor located in the basement for driving the passenger elevator; one 7½-HP. standard motor located in the basement for driving the screening conveyor belt; one 20-HP. standard motor for driving the transfer table; and one 100-HP. standard motor for driving the car haul.

All motors are started and stopped in their immediate vicinity, and are not operated from a central switch-room, as in some previous elevator installations. Auto-converters and two throw-switches constitute the starting device. These converters, switches and cut-outs are of dust and fireproof construction; being enclosed in cast-iron cases, lined with asbestos, and all electrical parts are mounted on white marble. The two 25-HP.

In 1883 the author designed a small spiegel furnace in Western Pennsylvania. It was built 66 ft. high, 12 ft. wide in the bosh, with a hearth of 6 ft. 6 ins. diameter. The furnace was constructed inside of an old-fashioned square stone stack. Space was most limited and cooling difficult to obtain. To arrange for this, a plate shell lined with 9 ins. of firebrick was used for the bosh, water being sprayed on the outside of the shell. The furnace ran for over two years, making an increased output of spiegel iron. It was then blown out for financial reasons. The bosh gave no trouble whatever. Red hot spots occasionally appeared on the plate shell, owing to unequal and defective cooling and the cutting away of the lining, but as soon as a spray was directed against such a point the trouble disappeared.

Later, in 1890, the author was entrusted with the construction of another furnace in Pennsylvania intended for the production of basic iron. It was built 75 ft. high, 18 ft. 6 ins. in the bosh and 9 ft. 6 ins. in the hearth. A plate bosh jacket was again employed, this time backed by a brick wall 13½ ins. thick. The furnace was successfully blown in and produced from 900 to 1,000 tons of basic iron per week. After about half a year it was, through an error of the superintendent, limed up almost past redemption. Cold blast and excessive temperatures sufficient to fuse the brick in the stoves were alternately employed: large charges of dynamite were exploded inside of the furnace below the now perfectly-formed, dome-like scaffold. Finally the scaffold was melted down with oil blow pipes and the furnace restarted. It then ran for a few months, when it again was scaffolded above the bosh and chilled. After the furnace had been dug out, the author was called on to examine and report on the lining. The lower portion of the barrel, where the scaffold had been formed, was somewhat worn, and the hearth, the walls of which originally were 40 ins. thick, was considerably cut away, but the bosh wall presented a smooth, regular and glazed surface from top to bottom. Directly in front of the spraying pipes the lining was somewhat thicker, but the average depth of the coating was proved to be from 7 to 9 ins. Holes were cut through it in two places, but no vestige of brick was found, the mass being, however, so hard as almost to defy the chisel. It was, therefore, reported that the bosh lining was good, and after some smaller repairs to the hearth the furnace was again started. It now ran for more than two years, and no trouble was ever experienced with the bosh walls.

It has, therefore, been demonstrated that a properly cooled iron plate exerts a protective influence on a brick wall built up against the same to a depth of from 7 to 9 ins., and also that the brick is gradually worn away or decomposed, a graphitic mass of about the same thickness taking its place on the inside of the plate.

From an economical point of view, the "Sahlin bosh" compares favorably with a bosh cooled by means of bronze plates, as will be seen by the following comparison of approximately estimated costs of a furnace bosh 14 ft. high, 19 ft. inside diameter at the top and 11 ft. diameter at the base, viz.:

Sahlin's Bosh:

One bosh jacket, with discharge trough complete, erected, including all expenses	£500
8,000 bricks, at £5 per thousand	40
Setting same at 30s. per thousand (plain wall)	12
Four 1¼-in. water pipes, at £2 each	8
Total cost of bosh, about	£560

Bosh Cooled with Bronze Boxes:

96 bronze boxes (8 rows)	£650
7 circular steel hoops	93
30,000 9-in. bricks, at £5 per thousand	150
Setting 9-in. bricks, at 50s. per thousand (arches)	75
One circular discharge trough, 12 by 18 ins.	150
Twelve 1¼-in. supply pipes with cocks at £3 each	36
72 connecting pipes at 10s. each	36
12 discharge pipes at 20s. each	12
Total, about	£1,202

These estimates are based on prices ruling in December, 1900.

The "Sahlin bosh" is practically indestructible, its life being as long as that of the ¼-in. steel plate. The thinness of the brickwork or deposit prevents the disruption of the jacket, so common in furnaces with thick brick walls. As the conductivity for heat of a plate is considered inversely proportional to its thickness, it is an open question whether a ⅜-in., or even a 5-16-in. shell should not give a better result than the ¼-in. plate, which has been used for the first furnaces at Millom.

The spiral troughs can be cleaned or scraped out at any time without shutting off the water. If required, a fresh supply of cold water may be added at any point of the descent. Two streams of water admitted near the top of the troughs will uniformly cool the entire surface of the bosh.

Everywhere in Great Britain the blast-furnaces are built on low columns. Their plate shells are of enormous diameters, sometimes as much as 32 to 34 ft. In remodeling these furnaces, it will be found difficult to arrange for cooling space and air circulation around the bosh. The "Sahlin bosh" will provide this, as it can be placed inside of the old shell at any height above the lintel plates supported by the columns. The angular space between the out wall and the bosh plate would not give access to a number of rows of cooling plates, but, however narrow the space, the spiral troughs can be reached and kept clean; while, for air circulation, a few openings cut through the brickwork and the outside furnace casing, close under the upper edge of the bosh, will suffice. It is, therefore, hoped that the new bosh arrangement will aid in the economical modernizing of our old furnaces.

SOME PECULIAR WRECKS OF STEEL CARS.

The accompanying cuts, reproduced from photographs, show some recent train wrecks in which steel cars have figured, and are a remarkable illustration of the capacity of cars of this type to stand the roughest sort of abuse with surprisingly little injury.

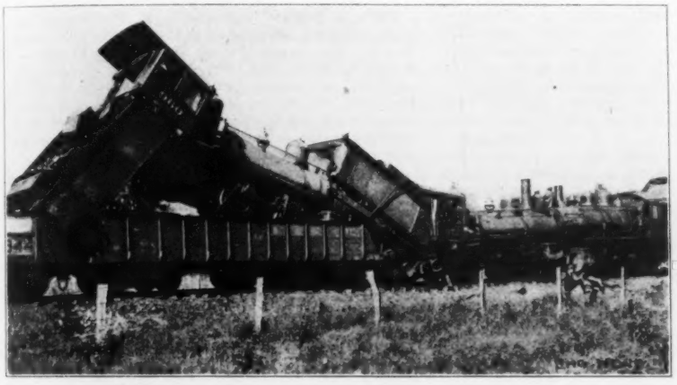


FIG. 1. A BUTTING COLLISION AT WARREN, O., SEPT. 5.

A DERAILMENT AT MAUCH CHUNK, PA., AUG. 10.

The wreck shown in Fig. 1 occurred on Sept. 5, near Warren, O., and was a butting collision between a heavy double-header freight train and an ore train. Behind the locomotives of the double-header train were two pressed-steel, 80,000-lb. gondola cars. When the trains collided the tender of the rear locomotive and then the locomotive itself mounted on top of the steel car behind it, which was shoved by the force of the train behind right under this locomotive, and finally came to a stop under the tender of the leading locomotive. As the rear tender slid back, however, it caught on the front of the second steel gondola and pushed up the rear of the locomotive to which it was attached till it stood high in the air, as shown in the photograph.

The steel car which was thus suddenly loaded with a locomotive and two tenders, suffered some damage, of course, but stood up under its load without sagging, and its trucks were not injured at all. Incidentally it may be remarked that the coupling between the two steel cars received about as severe a test as could be devised. We are informed that these steel cars at the head of this train saved the other cars in the train from serious injury. On the other train, however, a number of wooden cars were wrecked.

Fig. 2 shows a wrecking train picking up the results of a derailment at Mauch Chunk, Pa. On Aug. 10 last, a 60-car train was rounding a 9° curve at this point, when a broken flange on the wheel of a wooden car derailed it. Two wooden cars and several steel cars which were next behind them followed the first car off the track and went over the wall into the river, 20 ft. below. The smashup of the wooden cars was very thorough, as may be seen, but the steel car bodies appear to have suffered comparatively little injury.

The cars illustrated in both these wrecks were built by the Pressed Steel Car Co., of Pittsburg, Pa., to whose courtesy we are indebted for the photographs here reproduced.

THE PROTECTION OF FERRIC STRUCTURES FROM CORROSION.*

By M. P. Wood, M. Am. Soc. M. E.†

It may be stated almost without question that not 30% of the ferric structures of any kind or character in the United States have ever received a protective coating which is worthy of its name.

IRON OXIDE PIGMENTS.—Probably at this date iron oxide pigments, either in their natural condition, as ground red or brown hematite iron ores, or the same as a base to which a score of other substances are added by the paint compounding manufacturers, have been more generally used than any other pigments, natural or compound, for the protection from corrosion of ferric structures.

The color of these paints varies from a dark, dirty purple brown to a bright dark red—the Indian red of commerce. Their color is due to the processes of roasting, grinding and subsequent doctoring of the product to get a desired color tone. A few degrees more or less of heat, or a few seconds more or less exposure to the same, evolve a great diversity in the color, even if the composition of the pigment remains unchanged.

The process of roasting these hematite ores for pigments is not only with a view to the color, but to expel the water and the sulphuric and other acids in them. But this roasting expels only about half of whatever amount of these acids may be in the ore under treatment, even if the heat be long continued, which would ruin the color. The balance of the acids are only excited by the heat to a greater activity to restore a disturbed condition of their composition; besides, the lime and magnesia are rendered caustic, and when mixed with the oil carrying more or less uncombined water in it they slack as lime slacks in a mortar bed and set up a chemical action in the freshly applied paint, which, from experience, we know to be detrimental. To neutralize the sulphur element natural to the ore or developed in roasting, it is the common practice to add carbonate of lime (common chalk) to the amount of 5 to 10% by weight of the iron oxide, which, combining with the sulphuric acid, changes to a synthetically formed sulphate of lime (gypsum), which, however inert as a pigment and admirable as a stuffing, is not as desirable in this form as the natural gypsum would be. This change from a carbonate to a sulphate is wholly a chemical one, and takes place only when in the presence of and in contact with the oil, and is exerted at the critical moment of the first drying of the coating, and as it is not an instantaneous combination, the chemical action continues even after the paint has set, and necessarily must affect the whole character of the coating.

BOILED OIL VERSUS PIGMENT COATINGS.—Many eminent engineers have abandoned the use of iron oxide and other uncertain patent paint compounds, but still adhere to the use of oil for the first coating. The writer believes this method will bear fruit at no distant day in as calamitous a corrosive result as has attended the use of iron oxide, particularly in the case of all suspension bridge cables, anchorage bars, lattice trusses and other inclosed places where inspection or replacement

*Extracts from a paper read at the Milwaukee meeting of the American Society of Mechanical Engineers.

†230 West 44th St., New York city.

motors driving the conveyor belts, and the 15-HP. passenger elevator motor, are reversed by means of reversing switches. The car haul and transfer table motors run in one direction, the reversing of the machinery being accomplished by conical frictions.

The lighting of the building is accomplished by means of 1,000 16-c. p. incandescent lamps. Two 25-K-W. Westinghouse transformers are used for the conversion from 440 volts to 110 volts. The primaries are so arranged that they may be connected either to power bus bars on the elevator panel or fed from a three-wire auxiliary circuit from the station. The secondaries are distributed by means of four switches on the elevator panel, this controlling lamps by floors. About 16 miles of wire were used in connection with the electrical equipment of the elevator.

Telephones are used throughout the plant, an inter-communicating system bringing elevators, power station, office, etc., into communication with one another. From floor to floor single-point telephones are used. The telephones were furnished by the Holtzer-Cabot Co. A system of visual signals affords means of communication from the receiving legs at the main floor to the receiving scales on the scale floor.

MATERIALS AND QUANTITIES.—The following is a summary of material used in the construction of the elevator:

Foundation and Walls in Main Story.	
Number of piles driven	4,570
Timber and sheet piling, ft. B.M.	380,000
Excavation, cu. yds.	23,000
Masonry, cu. yds.	1,500
Concrete, cu. yds.	3,000
Cut stone, cu. ft.	1,300
Brick work, cu. ft.	45,000
Superstructure.	
Structure below bins, consisting of columns, knee braces, car and shipping hoppers, grillage beams and girders, etc., tons	1,850
Bins proper, consisting of bin plates, corner angles, tie bars, bin bottoms, etc., tons	6,500
Cupola material, tons	1,450
Legs and spouts below bin floor, tons	450
Legs and spouts above bins manufactured at elevator site, tons	350
Total tons	10,600

The total length of legs and spouts in the building is nearly eight miles. The number of field rivets is 2,000,000. Work on the foundation was begun May 1, 1899; work on erection was begun Jan. 1, 1900, and the first car of grain was received at the elevator on Feb. 26, 1901.

ENGINEERS AND CONTRACTORS.—The entire work was executed under the supervision of Mr. John F. Stevens, M. Am. Soc. C. E., Chief Engineer of the Great Northern Ry.; the elevator proper and all the steel construction was designed by Mr. Max Toltz, Mechanical Engineer, formerly Bridge Engineer, ably assisted by Mr. R. H. Folwell, Assistant Engineer. Mr. A. D. Bellinger, Superintendent of Elevators, West Superior, Wis., designed all the machinery, and was also consulted in regard to every detail, so that the steel construction could be properly designed. He also had charge of all the electrical machinery and its installment, assisted by Mr. Gustav Willius, Jr., Electrical Engineer. Mr. Robert Herzog, Assistant Engineer, had charge of the construction of the elevator. The Riter-Conley Manufacturing Co., of Pittsburg, Pa., furnished all the structural steel ready for erection, and the Kelly-Atkinson Construction Co. erected the whole building. The installation of the electric motors and all other machinery was performed by the forces of the Great Northern Ry. We are indebted to Mr. Toltz for the information from which this article has been prepared.

A NEW WATER-COOLED BLAST-FURNACE BOSH.*

By Axel Sahlin, M. Am. Soc. M. E.†

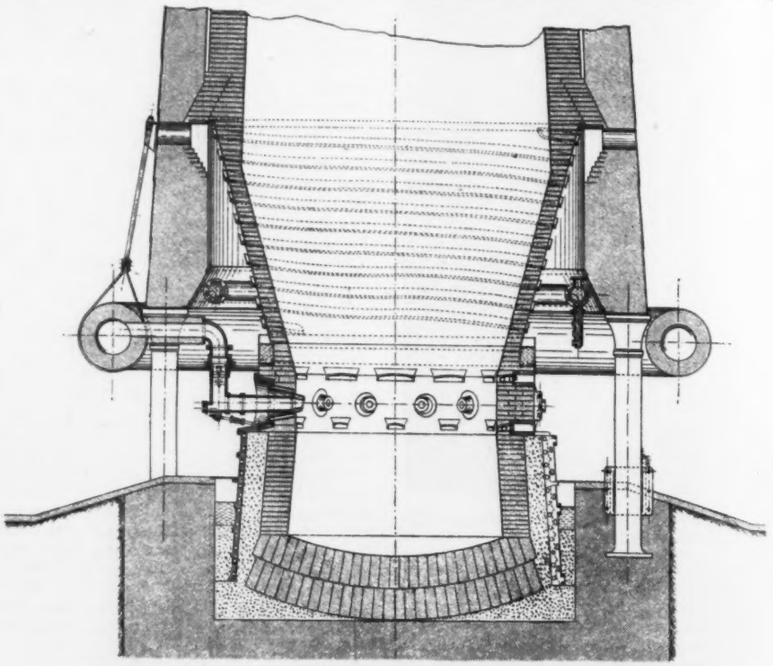
The problem of maintaining the bosh and hearth lines of a blast-furnace, subjected, as they are, to the combined destructive influences of high temperature and incessant abrasion by the descending materials, is one which has confronted all blast-furnace managers, and to the solution of which most of them have given much study and experiment. The result of these experiments and of the experience gained are the various forms of water-cooling devices which now are in use for protecting the walls of the lower part of the blast-furnace.

*A paper read before the Iron and Steel Institute of Great Britain, in May, 1901.

†Gen. Supt. The Millom & Askam Hematite Iron Co., Ltd., Millom, Cumberland, England.

In England, where in most cases small outputs satisfy both directors and management, the problem has hitherto been less difficult than in America. The custom in the former country has generally been simply to increase the thickness of the brick walls, on the principle, evidently, that it takes a longer time for a furnace to cut through a 6-ft. wall than to ruin one 2 ft. thick. When a furnace has been built from the beginning with a small hearth and with a bosh wide out of all proportion to the hearth and to the quantity of blast available, the shape of the furnace is of little importance. A few feet more or less on the furnace bosh has not made much difference, as long as the furnace never is made "to work all over." With these wide furnaces and slack blast you are practically blowing into an ore pile.

The brickwork surrounding this pile of ore is taxed but little and lasts indefinitely. Under these conditions, however, the control which the manager should have over the working of his furnace is to a great extent lost.



PART SECTION OF BLAST FURNACE, SHOWING BOSH AND BOSH JACKET.
Designed by Axel Sahlin, M. Am. Soc. M. E.

When, on the other hand, as in America, keen competition and high cost of individual labor make large output, rapid driving and close control of the furnace working imperative. When, therefore, the hearth must be enlarged, the bosh made to correspond and the pressure and quantity of blast increased, so as to make the furnace evenly effective throughout, then the brick walls themselves, and not scaffolds covering them, will give the outline of the working furnace. Even the best of firebrick, unaided by outside cooling influences, will then no longer resist the destroying action from within.

Amongst the means for cooling the blast-furnace bosh walls hitherto in use are: Open cast-iron or bronze boxes filled with water, closed bronze boxes under water pressure, copper pipes built into the brickwork, brick-lined plate shells sprayed on the outside, similar plate shells surrounded by successive rows of circular horizontal water pockets.

These are old and well-tried devices, each having its distinctive advantages and advocates, and also its drawbacks. The open cast-iron and bronze boxes, with their slow circulation, are liable to burn through or crack from unequal expansion, in which case the cooling water must be turned off, and the boxes become worse than useless.

The closed bronze boxes under pressure are very expensive in first outlay, and require a large quantity of clean water under a considerable head. As the side which they present to the fire is comparatively narrow, and the distance between the rows comparatively large, they tend to the formation of horizontal ridges on the bosh walls opposite each row of plates. If a leak should occur in a box, it is difficult to promptly locate, and as the water must circulate through the boxes under high pressure, great damage may be caused to the furnace before the defective box is discovered and the water turned off.

Water pipes and coils built into the brickwork are often broken by the expansion or settling of the brickwork. They are periodically getting clogged, are difficult to exchange and complicated to control.

The shell with outside spraying is sloppy, and on account of the slope of the bosh very difficult to cool uniformly all over.

Plate shells with horizontal circular pockets are not satisfactory, as the deep pockets, in spite of every attention, will get filled up with mud and incrustations, preventing the contact of the cooling water with the shell, which, in consequence, soon becomes leaky.

Perhaps the most general criticism which can be passed upon all the arrangements above described is that the cooling effect carried to the bosh walls is not sufficiently uniform at all points, the result being a tendency for the inside of the bosh walls to become ridged and uneven. At the same time all of them have many good points, and to-day successfully hold many a furnace lining to its intended shape under severe duty.

What is wanted, however, is a device that will meet the following conditions. It must:

(1) Maintain the furnace bosh at its proper diameter and slope during the entire campaign of the furnace.

(2) Be reasonable as to cost.

(3) Consume only a moderate quantity of cooling water.

(4) Be accessible for cleaning while the furnace is running.

(5) Supply mechanical strength and stability to the structure of the bosh.

(6) Permit of easy regulation of the amount of cooling at different levels as the zone of fusion is raised or lowered in the furnace.

(7) Ensure that no water can leak into the furnace.

To meet these conditions the author has designed and successfully employed at the Millom Works bosh castings, which he has reason to believe are original.

The device is illustrated in the accompanying cut, and consists of a plate shell in the shape of an inverted frustum. To the outside of this shell are riveted open troughs spirally wound around the plate from the top of the bosh to the circular discharge trough, which forms the base of the frustum. The bosh jacket is built of ½-in. steel plates, with flush joints, butt strapped on the inside and double riveted. The jacket is supported on the furnace walls by aid of a circular rim of a 4-in. × 4-in. × ⅝-in. angle bar. At the bottom it is riveted to a circular steel water trough. The spiral troughs are two in number. They are made up of 1½-in. × 1½-in. steel bar and an 8-in. × ¼-in. steel plate, forming, respectively, the bottom and front of the troughs, which are pitched at an incline of about ½-in. to the foot. The vertical distance from bottom to bottom of the spirals is 14 ins.

If water is admitted to the top ends of the spirals, the bosh will, therefore, at once be surrounded by parallel bands of flowing water about 3 ins. wide, spaced 11 ins. apart. The inside of the steel jacket is lined with 9 ins. of the very best firebrick obtainable, carefully fitted. Gradually this brick lining will disappear and be replaced by a layer of the characteristic silico-graphitic mass which the furnace deposits wherever the fire of the interior is met by an energetic external cooling action.

The experience which led to the design and adoption of this arrangement may be worth recording.

linseed oil can supply a demand for about 450,000,000 gallons of paints, varnish, japans and other uses, including the wastes of manufacture.

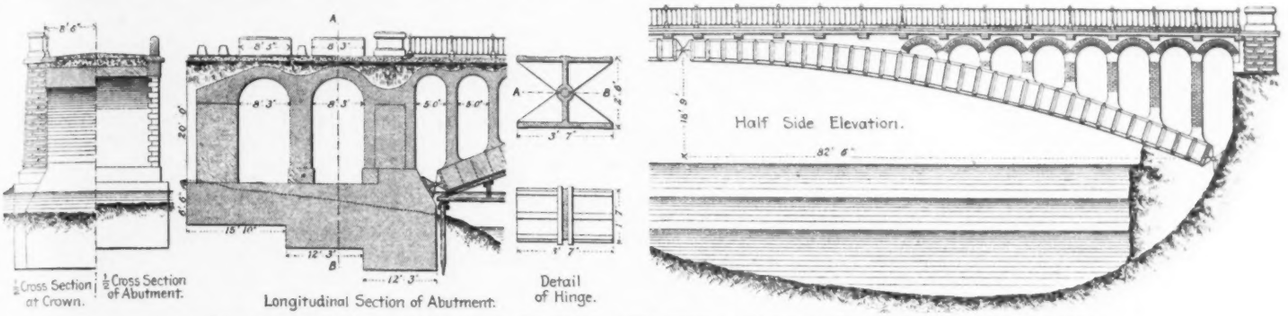
A new process of boiling oil has been adopted with some modifications and additions by a number of manufacturers. It furnishes an oil of light color, which dries well and rapidly, mixes with all pigments without leading to any discoloration. Whites retain their purity of tone unchanged; but with all these points in its favor the process cannot be recommended for the preparation of a vehicle to be used for a ferric protective coating. Briefly, the oil is first treated with a dilute sulphuric acid bath (containing about 30% of sulphuric acid), which is agitated with the oil by the air blast to dehydrate it, but is said to be not strong enough to carbonize it. After standing, to allow the oil and acid to separate, the oil is run off into the usual steam-jacketed kettle, heated to about 260° F., air is blown through the mass, while a solution of manganese linoleate in some hydrocarbon spirit (probably benzine) is added gradually during the process of heating and blowing. Cautionary care is required not to add too much of this material. It is the writer's opinion that this caution should extend to the point of not adding any manganese associated with any hydrocarbon vehicle to the oil, and that prohibition should extend to the use of any sulphuric, nitric or other caustic acid of any strength to the oil in its preliminary stage. It is almost impossible to clear an oil of either high or low specific gravity of any acid of whatever strength of solution to which it may be exposed. More or less of the clarifying acid will be held in the oil, either free or in combination, with the water in the oil, that even a long washing with water, aided by an air blast agitation, will not remove. Kerosene, naphtha, gasolene, etc., are purified by treating with sulphuric acid and then thoroughly washed with water and a long agitation by the air blast, and are then often found to contain acid enough to perforate the tin cases in which they are shipped. The slight improvement in the color of the boiled oil by this process is a very poor recommendation for its use. The same results are obtainable by the ordinary steam kettle process, using well known mineral substances; for instance, the zinc and manganese salts will remove or throw down the mucosities, clear the oil to any desired shade and cause it to dry promptly, while the water in the oil will be evaporated naturally by the heat and the dangers of the sulphur element avoided.

Of the many substitutes for linseed oil neither space nor patience can be given to note them. They are numbered by the hundreds in the Patent Office records, and outside in the formulas of the many paint compounders of the day, and are as uncertain and indefinite in character as the pigments which are assembled with them under the guise of paints. Linseed or other siccative oils of low commercial qualities and in small quantities are mixed with one or more of the score of flax dodders or buffums, resin, fish, burning and soap fat oils, india rubber and other impure substances, liberally dashed with benzine of high or low degree and braced up with a bung-hole boil of umber or other cheap driers, and then presented to the supply agent and public as pure linseed oil at a price below the regular market quotations of linseed oil from responsible business firms. The purchasing agent, as well as most of the master painters (except in a few cases) have not the laboratory, chemical apparatus or technical knowledge to detect the fraud, the results only being made patent by the slow gnawing of the tooth of time and at a period when it is too late to remedy except by the scraper, burning torch and a new coating that may or may not be better than the one that it replaces.

Probably 70% of all the oils, paints and varnishes manufactured in the world are applied to structures of minor importance, and which are destroyed in the course of time by other causes than corrosion. The coating of these structures is generally more a question of looks than physical condition, but the other 30% is used upon the largest, most costly and important engineering structures created by man. The most casual inspection of the ferric structures that line our railways and are counted by hundreds in the various cities of the country will show that they have not thus far received the intelligent treatment their importance demands.

PAINTING AT THE MILL.—Many engineers are advocating the plan of having a coating of protecting compound applied to iron or steel at the rolling mill as soon as possible after it has left the rolls or hammer and while the material is hot. The hot part of this plan is the only part to commend. All material from the forge or rolling mill has a tough, thick or thin (as the case may be) coat of loose or partly loose scale that adheres closely for the time being, but on a short exposure to the air, with a few changes of temperature due to the mill or storehouse conditions, releases its tension and is ready to fall off whenever roughly handled, as in the course of loading and transportation. No amount of brushing which any rolling mill employee would or could give to the material in its hot or half cold condition would remove this scale, and if the painter were present with his pot of paint it would get on over scales and all and no inspector could prevent it. The quality of this paint, even if rightly applied, would always be in question, and no contractor could be in any way sure that the contract requirements had been complied with, either in the removal of the scale or the composition of the paint.

All the machining operations are accompanied by more or less lubrication of the tool, and the oil used is invariably the cheapest to be had for that purpose, and has in general been used over and over again, is dirty and sour, and more or less decomposed, and carries enough hydrocarbon elements to evaporate to a dirty surface skin, hard to distinguish from the coating applied at the mill, the sequence being that the inspector, if careless in the discharge of his duty and anxious to get the work out of the shop, and to show a large day's work, does not notice the grease or other dirt due to the machining process which are not removed, but coated over by the ever ready painter. Rather let the material go from the mill or forge to the storehouse or construction shop, protected as far as possible from any unnecessary exposure to the elements, and when machined, during which process the greater part of the scale will be removed, and when the several parts are assembled in their relative positions and ready to be riveted up into their permanent places in the structure—if it is done at the shop instead of in situ, then and there is the place for the inspector to determine if the several parts are not only properly machined, but also properly cleaned from the scale which has not been removed by the machining process and handling, but that the grease and dirt is also removed in his presence, and the first coat of the paint is applied under his eye in a manner as to the conditions of temperature, frost, fog, wet or dry, and a quality of paint which will insure a proper protective result. Nothing can serve as a cloak to hide his own responsibility in the matter. One inspector and inspection at the last and final stage is better than two or more inspectors and inspections strung along over a chain of operations comprising months of time and often hundreds of miles between the links.


½ Cross Section at Crown.
½ Cross Section of Abutment.
Longitudinal Section of Abutment.
Detail of Hinge.
Half Side Elevation.

PROPOSED CONCRETE ARCH OF 165-FT. SPAN, WITH STEEL HINGES, OVER THE RIVER NALON, SPAIN.

A PROPOSED 165-FT. CONCRETE THREE-HINGED ARCH BRIDGE NEAR OVIEDO, SPAIN.

It is proposed to build a concrete arch bridge, of 165-ft. span, over the River Nalon, in Spain, near the city of Oviédo. The structure will be the largest masonry arch in Spain, and will be hinged at the crown and springing points.

The accompanying elevation of half the arch shows the general design. The arch is segmental in form, 165 ft. span and 18 ft. 9 ins. rise, from the center of the crown-hinge to center of the springing-line hinge. At these two points the depth of the arch will be the same, or 3 ft. 7 ins.; but midway between these points the depth will be 4 ft. 8 ins. At the right abutment the rock will be cut away so as to form a surface perpendicular to the axis of the arch, and on this will be fixed the lower hinge. For the left abutment a foundation will be provided by digging down to a depth where the resisting power of the subsoil will withstand a maximum pressure of 3½ tons to the square foot.

To provide for flood water, two discharge arches, each 8 ft. 3 ins. wide, will be built in one of the approaches. These openings will also be built of concrete, but they will be faced with ashlar masonry. The main arch is to be faced with brickwork, and it will carry spandrel arches—of 5-ft. span—supporting the roadway, which latter will be 17 ft. wide between the inside of the parapet walls. No provision is made for separate footways, and the parapet is open cast-iron work. The spandrel arches and piers are faced with stonework, like most of the exposed parts of the structure.

The hinge is shown in the illustration, and is virtually an upper and lower shoe and a central pin, all of steel, 2 ft. 6 ins. high, by 3 ft. 7 ins. long, by 1 ft. 7 ins. wide, when assembled together. The metal in the shoe-plate is 2½ ins. thick, but the diameter of the pin is not stated. Distributing plates will probably be used in transferring the load to the abutments.

The proportions of the concrete, by volume, specified for the arch are, cement 1 part, sand 2.5, and broken stone 5 parts.

The accompanying illustrations and the description from which our information is taken, we find in "The Engineer" of Sept. 6, which gives credit for the original publication to "La Revue Technique."

THE COMMERCIAL PACIFIC CABLE CO. was incorporated in Albany on Sept. 23 with a capital of $100,000, and John W. Mackay and Clarence H. Mackay among its incorporators. The object of the company is to connect New York with San Francisco with its own wires or those of existing companies; and then to lay a submarine cable to the Hawaiian Islands and thence to the Philippine and other Pacific islands. Mr. Mackay, in an interview, said that the cable to Hawaii would probably be laid and in operation in nine months, and he "believed" the whole system would be in operation within two years from this date. His company is ready to construct the cable line without asking for a government subsidy or guaranty, and expected no difficulty in obtaining landing rights in California, Hawaii and the Philippines. At the latter islands the cable would connect with the existing submarine cables leading to Japan and China. Mr. Mackay thinks the new line would reduce present cable rates from 30 to 60%.

AN AUTOMOBILE MILL AND BAKERY for military purposes is being tested in Switzerland. It includes a grain mill, flour bolter and kneading trough, operated by the motor when at rest; and an oven is drawn along as a trailer. By this method it is claimed bread can be supplied to 5,000 men daily. It would also be useful on contracts which bring together large numbers of workmen.

THE MANCHESTER SHIP-CANAL CO. at its recent half-yearly meeting, presented the report of the managers. This report was criticised by Marshall Stevens, who said that the net result of the past 12 months' trading was a loss of $1,000,000, the bulk of which had gone to swell the amount due for interest to the Manchester corporations. This Manchester interest account was now almost as large as the whole capital amount of the first mortgage debentures, and the shareholders were at any time liable to lose their property. He thought that some definite arrangement should be made with the Manchester corporations with regard to payment of interest and principal. The chairman replied that the directors would be glad to consider any scheme laid before it by the shareholders which would be for the interests of the company.

is practically impossible. Certainly, a pigment coating can be applied anywhere and as easily as an oil coating, will dry as quickly and as hard, and at any stage of drying will resist mechanical injury due to handling, transportation and erection better than the oil coating; and if storms of any character reach the coating, as they certainly will, they will not so injuriously affect it, either in a minor or major degree, as they do an oil coating. Finally, if the oil coating is so supremely good for the foundation coat, why not extend the goodness and make all the coatings of oil alone, and save the cost of the pigments in the subsequent coats and retire the whole corps of paint compounders and salesmen to the shades where rest the remains of the lamented iron oxides?

No theory that the oil alone will soak into or beneath the loose, or partially loose, scales and rust on the body coated is tenable in the face of the fact that these scales and rust must be removed in order to secure a favorable result with any coating. There is absolutely no excuse for allowing them to be coated over or incorporated into any coating.

Late advices as to the condition of the great cantilever bridge over the Firth of Forth, Scotland (finished less than 10 years ago), show that corrosion is well and widely established over the entire structure, notwithstanding that a corps of painters are continuously employed upon it, and the structure is practically repainted every three years, and in many places yearly. Upon the lower parts, where the ironwork rests upon the masonry, and upward, where the spume and salt spray from the sea reaches the work, corrosion has attacked the rivet heads and laps of the angles, channel bars and plates and cannot be controlled by the scraper and paint brush. This structure received two coats of boiled oil at the shop before erection, and then two coats of iron oxide paint, each of which required 90 tons of paint. It is the opinion of the writer that before the bridge has had 30 years of existence it will have to receive the drastic action of the sand blast for all parts which can be reached by that process, and that even that will not wholly remedy the evil. The lower sections for 20 ft. or more in height from the masonry piers will be so corroded they will have to be cut out and renewed, if they can be. Thousands of the rivets, many of them 1¼ ins. to 1½ ins. diameter by 9 ins. in metal, will be so corroded under their heads as to have lost their set. In fact, the stability of the bridge in the future will rest quite as much upon its mass as upon the mutual strength of its connecting members. Some one was knighted for the ability shown in the construction of this bridge; it may be that somebody else will get two buttons on his bonnet for being able to take care of it.

Inspection of work in progress shows quite as great a disregard of all the essentials to secure even a temporary protection from corrosion as any of the earlier methods for this purpose, the disastrous results of which are forcibly recorded in Brunel's tubular bridge across the St. Lawrence River at Montreal, the trusses of the Brooklyn suspension bridge, the New York city elevated railway and many other important structures, hardly one of which presents a good example of protection from corrosion under even ordinary atmospheric exposure. Scores of tons of material, piled at many points along the line of the New York rapid transit tunnel, show mill-scale plentifully present on the principal members of the columns, girders and other parts, all painted over. Many parts, indifferently closed by the rivets, show them to be unpainted on their inner surfaces, and are of such construction that it is now impossible to coat their inner surfaces even by the action of a force pump. Hundreds of minor parts are painted in so careless a manner that the protective coating is but little better than a wash of brick dust, the curdled appearance of some of the coatings clearly indicating that the red lead paint had set before its application, and that the pigment is of an inferior quality. The greater part of this steel work is to be placed where it will be always damp or so walled in as to be inaccessible for inspection, or else exposed to an atmosphere always charged with tunnel vapors, with what effect upon its resistance from future corrosion the experience of the past can give but one answer. Surely, if the boards of admiralty of all the nations in the world deem the removal of mill-scale from the frames and plating of a hundred-ton steam tug of importance enough to resort to the pickling process for its removal before painting, those who are responsible for not only the construction, but the future condition and life, of a $30,000,000 tunnel could afford to adopt some better method of guarding the work against the disastrous results from future corrosion than that now evidenced. The hydric sulphide in the combustion gases from the locomotives in use in any part of the completed tunnel pending the inauguration of the electric motor power will reach and destroy the red lead pigment regardless of what coating it is in, or in whatever amount it forms a part.

It costs as much to spread a poor paint over a structure as a good one, and the labor is generally from two to four times the cost of the paint. There is not difference enough in the covering power of different paints to allow it to be any factor in deciding between them. All paints will spread over about the same number of square feet of surface if they are of the same body or weight per gallon, and the same care is used in brushing them out; but the hiding power, or power to cover up a poor job on the part of the painter, or to mask the effects of corrosion already in place, lies almost exclusively in the iron oxide paints. Given a ferric structure to be protected from corrosion, the several parts after the machining processes and assembling in their relative position in the workshop, and before a single rivet is driven or a bolt placed permanently in position, all scale, loose or tight, that the scraper, hammer, chisel or steel brush can remove should be removed, not scratched at; better yet, sand blasted. The latter need not cost over ½ ct. a square foot of large and small surfaces, and this process would remove the dirt and grease due to the machining processes. It is the painter's custom to brush the grease with benzine and spread it over a larger surface, and as the mixture is not wiped off dry with waste at once it dries down again, and the evil is only increased, the effects of the benzine on the surface aiding the evil. Turpentine is a better solvent agent than benzine, but that must also be wiped off, not allowed to dry down mixed with the grease. No paint applied over a grease coating will ever bond to the iron. The writer has removed skins of good elastic paint coatings as large as the hand from important members of a truss which had been coated over with machine grease for a number of years. Such places are a fruitful cause of corrosion, particularly pitting, as they are likely to be found in inaccessible places, like the inside surfaces between tension tie bars, etc.

The first paint coating applied at the shop should be done in a dry, clear, warm atmosphere, either under cover or in the sun. Never paint iron in a fog or with frost in the pieces, even if to the eye they look dry. Glue applied to the warm surfaces of wood is 10% stronger than when applied to cold surfaces, and so will any paint cover and bond to the iron better if the surface is warm. The permanency of white lead mill marks on iron plates is due to this cause alone. It is a matter of no importance what the color of the first coating is, so that it is the best in quality of all those that are subsequently applied. A pure lampblack (not ground soot or bituminous coal), with boiled linseed oil, can be ground and mixed for a light or heavy priming coat with the most satisfactory results in the protective qualities. This is true also of red lead and lampblack, a chocolate-colored mixture, the two pigments uniting and working together when ground in the boiled oil as hardly any other two pigments are capable of doing, and there is hardly any other paint in which it is easier to detect adulteration. A small percentage of zinc oxide pigment works well with this red lead and lampblack mixture, and does not detract from its protective qualities for either wood or iron surfaces. It is probably as good a compound paint as can be mixed from a number of pigments not united as one body in its natural condition, but the influences to which any paint will be subjected must receive as much consideration as its composition. All paints containing red lead are extremely sensitive to the action of hydric sulphide, or the combustion gases from coal.

ASPHALTUM COATINGS.—The so-called asphaltum paints in general have thus far proved to be quite as ineffective protective coatings as any of the iron oxide or miscellaneous compound paints. Their name is a misnomer, as few, if any, contain 5% of asphaltum, and even that amount is seldom treated to free it from the vegetable matter and acids with which it is associated in its natural state, and, as a rule, the substances incorporated with it as pigments are quite as carelessly chosen, and uncertain in composition as the asphaltum itself, which is simply the residuum from evaporated petroleum, and contains in its natural state often as high as 10% of sulphur. Benzine and bisulphide of carbon (made by passing the vapor of burning sulphur over burning charcoal) are generally employed as solvents of the asphaltum in the preparation of the menstruum, and whatever pigments are incorporated with it they are more or less affected chemically by the bisulphide ingredient. They are in no respect a synthetical mixture, either in the pigment or paint, but are mechanical, haphazard compounds drying by evaporation instead of by resinification. Its name is a catchy one to conjure with and to sell the product, and its use should be confined to the many minor ferric constructions of the day, but not allowed on the more important structures, whose condition should be always above suspicion of corrosion. Its low price is a strong element in its favor with purchasing agents and indifferent bridge painters, where quantity rather than quality governs. A moderate price in a bridge paint usually denotes a moderate or no result in a protective sense.

Bitumen, asphaltum and other varnishes, not paints, have not received the attention from engineers and other persons responsible for the care and protection of our ferric structures that their merits deserve. This is probably owing to their high cost. The skill required in their preparation debars the average paint compounded from attempting their manufacture, and more care is required to apply them than the cheap painter will give.

It is possibly a too radical departure from the old-time methods of protecting ferric structures by the paint brush and a pot of some sort of compound called paint for many engineers, either in construction or in charge of repairs, to consider the merits of a baked japan coating, such as is described by Professor Sabin, under the name of "baked coating," which has proved to be so reliable to prevent corrosion under hydraulic and underground [illegible]. The process is peculiarly adaptable for all the chord bars, lattice posts, struts and other members which [illegible] position are so closely set together, or from their lattice [illegible] form, that their actual condition on the inside [illegible] can never be ascertained, only guessed at; and can never be either inspected, scraped or repainted in such a [illegible] as to insure their being absolutely protected against corrosion, which, once established, must proceed, and [illegible] too, on the very parts of the truss on which its [illegible] is dependent.

The edges of all channels, angles, tees and other special truss forms are a well defined round, and when closed together or to plates or bars in the many types of bridge construction form at their intersection a re-entering angle or groove, instead of a salient one. Besides, the rough edges of these forms and this rough re-entering angle are hard to paint, as the paint will not flow down [illegible] them of its own volition, and the painter is generally too careless to fill them with his brush, even if the confined strip of air did not refuse to escape as the paint-loaded brush is drawn over it or slapped on it. Particularly is this the case if the surfaces are cold or damp. These places are not few in number and of no moment, but are to be found by hundreds of lineal feet in any structure of magnitude, and are almost invariably the seat of corrosion. They are seldom scraped out in repainting the structure. The ballast and street dust, cinders and ashes from the locomotives find ready lodgment at these points, and are not washed out by the storms, only kept moistened and ready to commence their corrosive work at the earliest moment possible. The destructive carbonization of bituminous coal for coal gas or for hard foundry coke only eliminates about one-half of the sulphur in it, the other half being found in the resultant coke. About one-half of this remainder is consumed in the high heat of the locomotive firebox and the balance is found in the ashes and cinders. The soft coal used on many railway lines often contains 4% of sulphur, and a solution from the ashes and cinders is strong enough to redden litmus paper. Small wonder that many bridges are in an advanced state of corrosion within 10 years of their erection.

There is nothing impracticable in applying a baked japan coating to all these parts of a railway truss, except, possibly, the end posts and top chords which require to be riveted up in position. The floor beams, stringers, etc., could receive the same treatment, while the added protection from this process manifest in the lessened amount for materials and labor in the frequent repainting of the structure would probably equalize the cost as compared with paint within comparatively a few years.

The nearer any protective coating approximates an enamel or varnish, generally the more durable it will be. The Japan and Chinese lacquers are varnishes, and dry better by the application of water than in dry air alone, and all compounded varnishes are hardened in the last stages of their drying by water. Lacquers, when thoroughly dry, remain unchanged for scores of years when exposed to either fresh or salt water, hot or cold, alternately wet and dry, or immersed. The coming ferric protective coating will probably be a true varnish, with a carbon or graphite pigment. But it will be well to bear in mind that it will not be imperishable in exposed locations, and that its application and the preparation of the structure to receive it will require more attention than at the present time these matters generally receive; neither will it be a low cost article.

LINSEED OIL.—Unripe seed, or seed from flax raised for the fibre only (the condition from which most of the commercial oil is obtained), contains nearly 10% of water. The yield of oil from the different classes of linseed varies only from 23 to 28% of the weight of the dry seed. Linseed yields in the process of extracting the oil, viz.:

Cold process	about	20% of oil
Hot process	"	27% " "
Carbon disulphide process	"	33% " "

or 15 to 18 lbs. of oil per bushel of commercial seed, by the most improved processes of extraction.

The vegetable siccative oils of commercial importance are 20 in number, the principal of which are linseed, poppy, hemp, walnut, sunflower, grape, Scotch and silver fir and spruce. The specific gravities of the whole number (20) range from 0.9202 to 0.9358, varying so little that the hydrometer test is of little moment to determine their character. The vegetable non-siccative oils of commercial importance are 76 in number, the principal ones being the castor (specific gravity, 0.964), olive and cottonseed (specific gravity, 0.9306, almost identical with linseed), resin, almond, beechnut, horse chestnut, hazelnut, peanut, croton, sesame, colza, rape, mustard, with specific gravities ranging from 0.913 to 0.942. They mix thoroughly with each other as well as with the siccative oils, and the specific gravity of a pure linseed oil can be easily counterfeited, even if its quality cannot be. Vegetable oils additional to the above, used medicinally and for soap, burning and food, are 85 in number.

Vegetable oils, volatile and essential number 134, or a total of 293 non-drying oils available for the purpose of adulteration. Add 80 animal and fish oils to the above and the sources may be conjectured from which a yearly production by the whole world of 200,000,000 gallons of

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, } ASSOCIATE EDITORS.

A. B. GILBERT, - - - - - - - ASSISTANT MANAGER.

CHAS. W. REINHARDT, - - - - CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York, M. C. ROBBINS, Chicago, S. B. READ, Boston, C. F. WALKER, Cleveland, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & CO, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE. 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.90 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current Volume, 15 cents.

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 321 means that subscription is paid to the 32d week (that is the issue of Aug. 8) of the year 1901; the change of these figures is the only receipt, unless one is sent by special request.

ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

For a number of years there has been a demand for standard specifications for cast-iron water pipe. Several organizations have committees on the subject, including the New England Water-Works Association and the American Water-Works Association. The former committee, as noted elsewhere in this issue, presented a preliminary report at the annual convention of the association at Portland last week. That report referred to the existence of similar committees on behalf of other organizations, but gave no evidence of an attempt to secure joint action. If the various committees have not already taken steps to do so, it seems extremely desirable that they should join forces and try to agree on one standard specification, instead of having two or more standards. One of the difficulties in the way seems to be the fact that the American Association does not have another meeting until spring, so if its action were awaited, the proposed specifications would have to remain open to amendment for nearly a year. But this appears to be one of the cases where a little delay might be advantageous. The New England Association cannot take formal action before its meeting on Nov. 13. We understand that the report of the committee is to be printed for circulation before that time, so there will be an opportunity for the committees of the other associations and such of the other members as are interested to consider the proposed specifications and make suggestions for changes or additions.

Epidemics of typhoid fever resulting from a polluted public water supply, such as occurred at Plymouth, Pa., a number of years ago, and at New Haven, Conn., last spring, ought to sound a note of warning to every city dependent upon surface water supplies, and doubtless would do so if the general public really appreciated their significance. Yet how few American cities are taking adequate measures to protect their inhabitants from similar catastrophes!

As many of our readers will recall, both the Plymouth and the New Haven epidemics were caused by cases of typhoid fever in isolated farmhouses located on the drainage area from which the city received its water supply. In each case there was carelessness in the disposition of the dejecta from the patients. At Plymouth a thaw melted the snow and swept millions of typhoid germs into the water supply. At New Haven a very heavy March rain produced the same effect. Among the very few American cities which are taking measures to guard themselves against such fatal epidemics, the most notable example is afforded by the city of Boston and by its successor, the Metropolitan Water and Sewerage Board, which now controls the sources of water supply of Boston and vicinity. The work in behalf of Boston was inaugurated some twenty years ago by Mr. Desmond FitzGerald, Past-Pres. Am. Soc. C. E. At the convention of the New England Water-Works Association last week, Mr. Wm. W. Locke, Sanitary Inspector for the Metropolitan Water and Sewerage Board, reviewed the work begun by Boston, and continued by the Board. Some of the information given by Mr. Locke will be found in the report of the convention, elsewhere in this issue. The full paper will be printed in the Journal of the Association. These efforts to prevent water pollution consist, first, of rules prohibiting the deposit of polluting matter in any stream or lake in the drainage area, and of the location of privy vaults or cesspools within prescribed limits. The second part of the work consists in detecting and abating sources and possible sources of pollution. Obviously, rules are of no use unless they are enforced; and they cannot be enforced without systematic inspection. Unless we are greatly mistaken, nearly all the attempts thus far made to prevent water pollution in America have stopped short with the enactment of laws by the various state legislatures, and the formulation of rules relating to specific drainage areas by a few State Boards of Health. The legislatures of New Hampshire, Massachusetts, and New York have authorized their respective State Boards of Health to make rules and regulations for the sanitary protection of specific water supplies on application by local authorities. Doubtless this practice will extend to other states, and local authorities will file requests for such regulations more generally in the future than they have done in the past. With the establishment of such rules should go the work of inspection. The rules, however, may be of considerable service where there is no systematic inspection, and much good may result from inspection even if there are no legally-established rules. In the latter case resort would be had to common law or to general statutory prohibition of the pollution of public water supplies.

Two of the most fatal railway accidents that have been recorded in a long time occurred during the past month, and in each case the accident was a rear collision due to the running away of trains on a steep grade. The most recent of the two is that at Palota, Austria, on Sept. 21, where a train loaded with petroleum ran down a steep grade and struck the rear of the Vienna express. The number of deaths in this accident is given in latest cable dispatches as 32. Most of the victims were burned to death in the huge conflagration which followed the collision, and which was fed by the oil from the wrecked tank cars.

The earlier accident was like that in Austria also, in that fire followed the accident, but the fire was set in this case by the cook-stove in a private car on the rear of the train which was struck. As noted in our issue of Sept. 5, this accident occurred on the Great Northern Ry., in Montana, on Aug. 31, and resulted in the death of 36 persons and the injury of 13 others. It was caused by the break-in-two of a freight train, which was backing out of a siding; 28 cars on the rear of the train broke away and ran down grade for 16 miles, striking the passenger train just as it was leaving a station.

Both these serious accidents, it need hardly be said, point to the need of greater care in the maintenance of brakes and brake rigging. We have no knowledge of the character of the brakes on the foreign railway concerned; but in the case of the American accident it seems wholly inexplicable that such an accident could be possible. If the train were equipped with air brakes throughout, the brakes on the whole train should have been set when the hose separated as the train broke in two, and should certainly held long enough to bring the train to a stop. If, however, the brakes were in such bad condition that they began to leak off at once; then should certainly hold long enough to enable a brakeman to wind up enough hand-brakes to keep the train from starting, or else to check it when it did get under way. Perhaps, though, there was no one aboard this string of 28 cars when they broke away. In fact, it seems likely that this was the case, for that these cars could run 16 miles with even one man on board able to set up brakes seems far from likely. Accepting this view of the matter, however, it is pertinent to inquire what kind of discipline obtains on a road where a freight train is allowed to get under way with no one in the rear caboose, or anywhere on the rear 28 cars of the train.

Every such accident ought to teach some valuable lesson, not only to those officers who happen to be made familiar with its circumstances, but to railway officers in all parts of the country. Under the present circumstances, however, this is impossible. The railway company keeps all circumstances in connection with the accident a secret within its own official circle; and the valuable lessons which ought to be drawn from every such occurrence for the benefit of railway officers and operatives everywhere are almost wholly lost. What is needed is a searching investigation into the causes of every such accident, to be made by experts of experience and ability, not so much with a view to fix the responsibility for it as to bring prominently to light the methods or appliances which chiefly contributed to it.

In Great Britain, such investigations are made by expert engineers under direction of the British Board of Trade; but in this country the only public investigations worthy of the name are those which a few State railway commissions have occasionally undertaken. The coroner's investigations which frequently follow fatal railway accidents are a huge farce in ninety-nine cases out of a hundred, so far as developing the technical facts that ought to be made known for the benefit of railway practice. The State railway commission investigations, too, seldom amount to much in a technical way, for lack of expert knowledge on the part of those in charge.

It is a fact which cannot be glossed over that accidents are by far too frequent in American railway practice. The figures are appalling: 2,500 employees killed and 40,000 injured in a year, while 250 passengers also met deaths and over 4,000 were injured. At the last Congress a bill was introduced which was designed, we believe, to provide for an expert investigation into the causes of accidents, under direction of the Interstate Commerce Commission. Unfortunately, the bill as finally enacted provided only for more complete accident reports to the commission, to be used for statistical purposes only, and the opportunity for effecting a great public benefit was lost.

SOME THOUGHTS CONCERNING CHANGES IN BRIDGE DESIGN.

There was a time, easily within the memory of men in active life, when iron was used in bridge construction as if it were precious metal—as to a certain extent it was. The engineer had just found out how to compute the stresses in each and every member of a truss, and he was so proud of the ability that he computed and tested and planned and figured in the endeavor to make every member just as strong as the others, like the famous "One Hoss Shay," and so to distribute his metal as not to waste a pound of it anywhere.

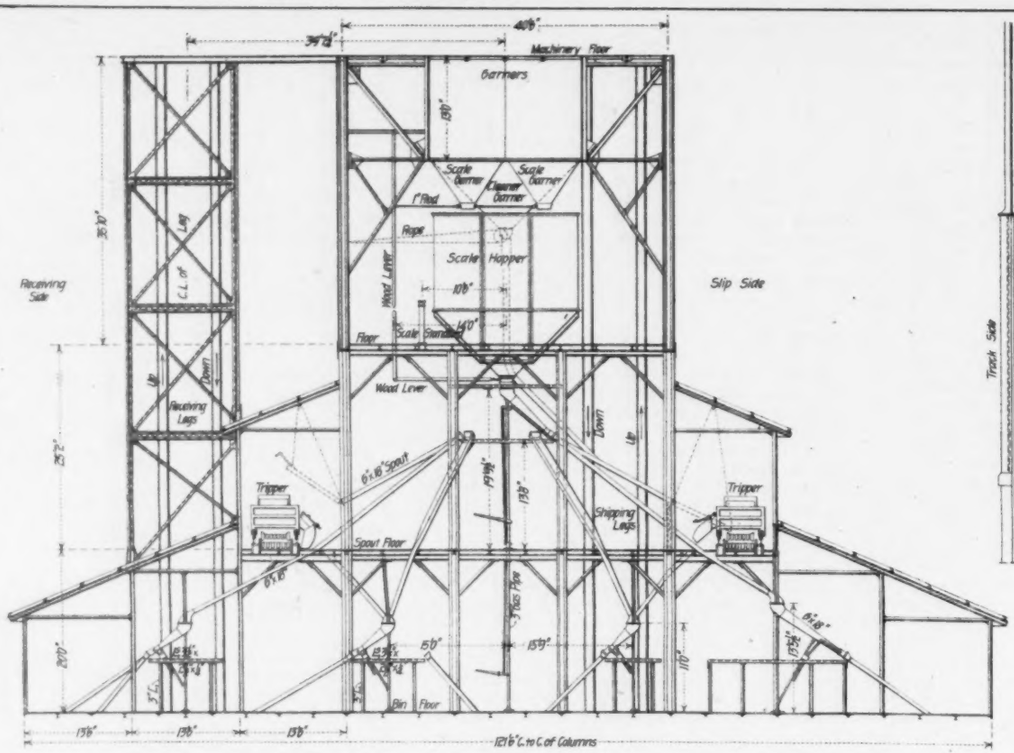


FIG. 11. TRANSVERSE SECTION THROUGH CUPOLA SHOWING SPOUTING AND MACHINERY.

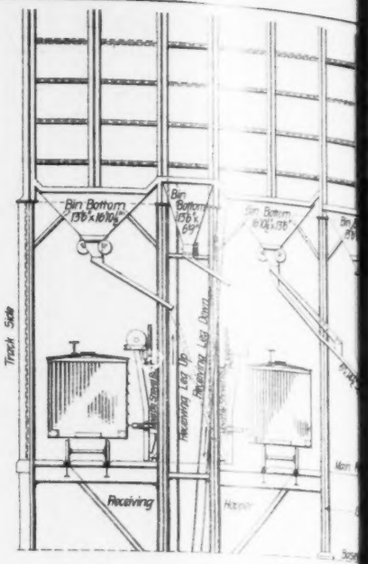


FIG. 9. TRANSVERSE SECTION SHOWING SPOUTING

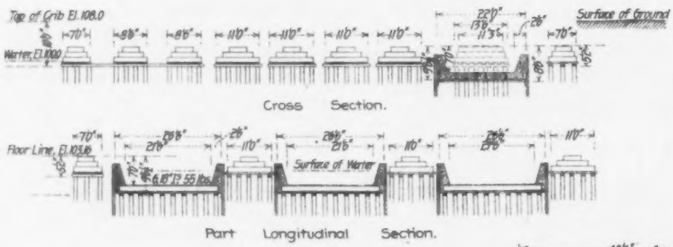


FIG. 3. SECTIONS SHOWING FOUNDATION CONSTRUCTION.

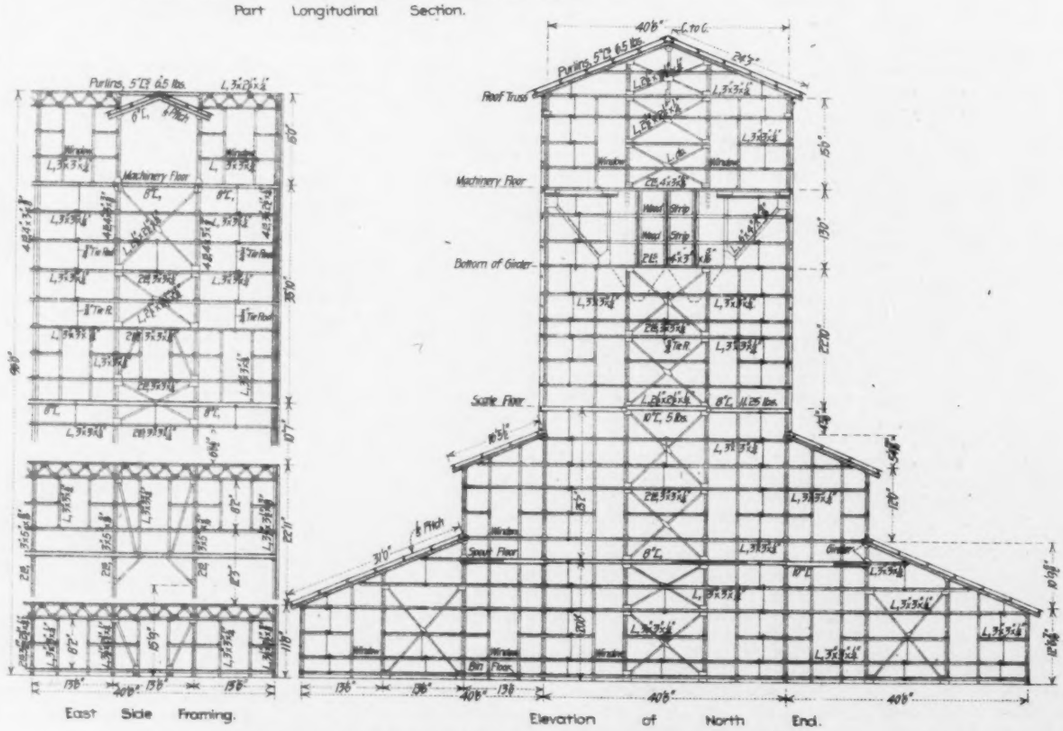
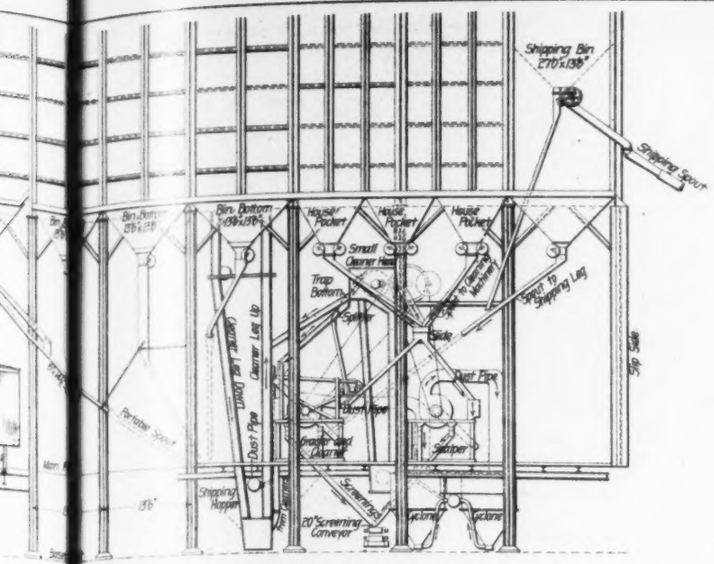


FIG. 6. SECTIONS SHOWING FRAMING ABOVE BIN FLOOR.

FIG. 2. TRANSVERSE SECTION THR

3,100,000-BUSHEL STEEL GRAIN ELEVATOR FOR GREAT N

John F. Stevens, M. Am. Soc. C. E., Chief Engineer; Max Toltz, M. Am. Soc. C. E., Mechanic



9. TRANSVERSE SECTION THROUGH MAIN FLOOR SHOWING SPOUTING AND MACHINERY.

NSVERSE SECTION THROUGH ELEVATOR.

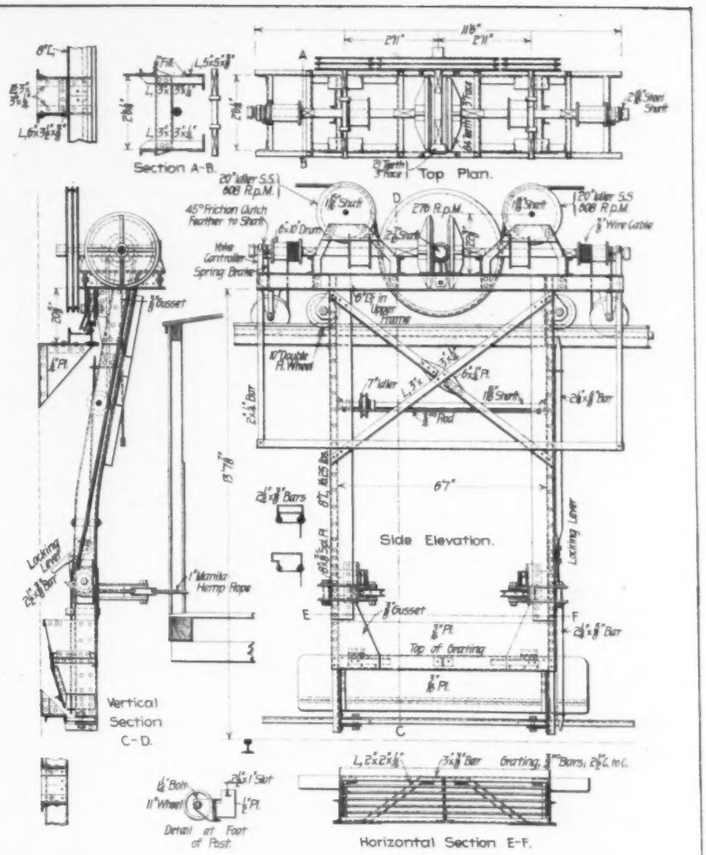


FIG. 10. DETAILS OF POWER SHOVEL FOR UNLOADING CARS.

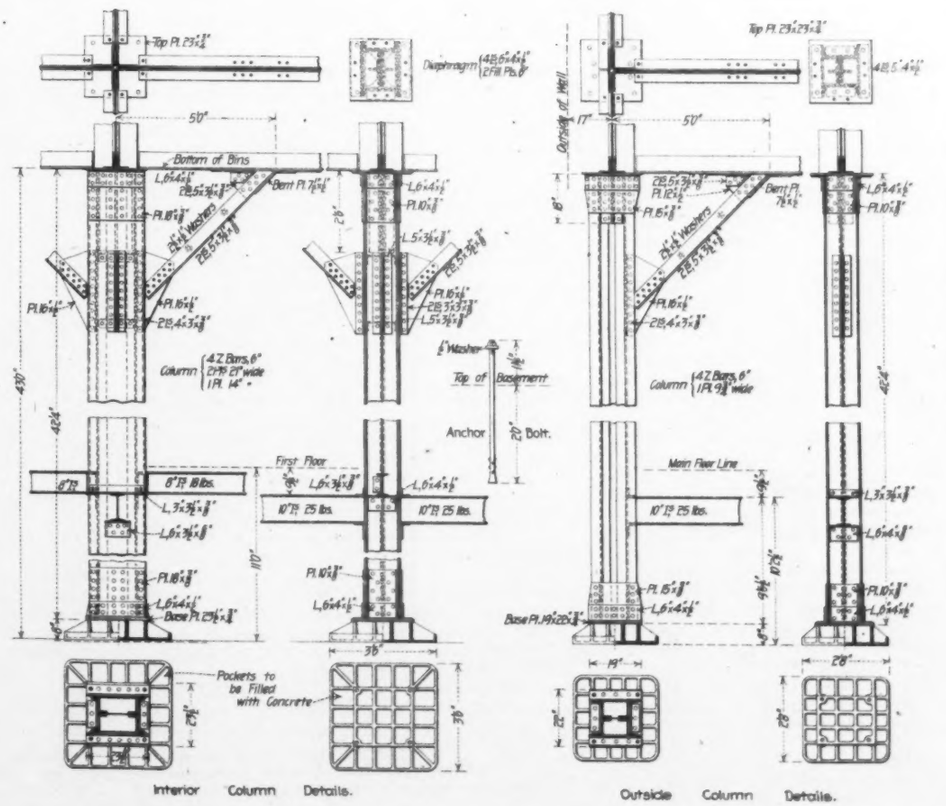


FIG 5. DETAILS OF COLUMN SUPPORTING BINS.

R FOR REAT NORTHERN RY., AT WEST SUPERIOR, WIS.

c. C. E., Mechanical Engineer; A. D. Bellinger, Superintendent of Elevators, Great Northern Ry.

CHAS. HART, LITH., 88 VESEY ST., N. Y.

The engineers who planned and the people who paid for these early iron bridges thought and believed that they were building and paying for permanent structures. The old wooden bridges which they replaced had required more or less frequent repairs, and had finally succumbed to age and decay. They were recognized as essentially temporary structures, and when replaced by iron trusses, it was believed by all parties concerned that something had been erected whose renewal would be a matter of the far-distant future.

But as one now goes about the country and looks over these structures built 20 to 40 years ago, he must be impressed with the fact that many of them are destined to have a life no longer that some of the wooden bridges which they replaced. A very large proportion of the early iron railway bridges have already given place to heavier structures, and in some cases these again have had to be changed for still heavier. A similar reconstruction must unquestionably be carried on among highway bridges, and here again much has already been done.

It is a current idea that all these changes and reconstructions have been made necessary by the increasing weight of rolling stock on railways and by the heavier character of traffic on streets and roads. This is true; but it is not all the truth by any means; and it has seemed to us that engineers, as a whole, are not learning all the lessons they ought to learn from experience with these early structures.

It must be freely acknowledged that rust and wear have been two powerful contributing causes to shorten the life of these early iron bridges; and to an extent that their designers and builders never foresaw. They put in light cobweb-like members built up of sections rolled as thin as the metal would squeeze and connected by a delicate little lacing of thin strips, and prided themselves on their economy of metal. They forgot that rust would work, year after year, on those thin sheets of metal and eventually weaken them to a degree impossible to determine. They computed "factors of safety" with a beautiful precision; but they failed to provide a factor of safety against 20 years or 40 years of rust.

Again, they computed their bridge for static loads; but they forgot or failed to understand that on small-size bridges where the dead load is small, movement takes place whenever a load crosses it, and that movement means wear at any points where such movement can take place.

As a result of this dear-bought experience, we have the girder replacing the truss for short-span structures, and unquestionably a great improvement upon it. The girder can be protected with paint much more readily than a truss, and has no moving parts to wear. The life of a well-designed girder ought to be, perhaps, double that of an ordinary truss of short span.

While the railway bridge builders have learned this lesson pretty well, as much cannot be said for the builders of highway bridges. All over the country short-span bridges are still being built with iron or steel trusses, which will be a heavy burden on the taxpayers to maintain, and whose construction would never be countenanced if the people who pay for them understood in how few years they will wear out and rust out.

For another example of the slowness of engineers to learn from the plain teachings of experience, take the matter of bridge floors. Nine-tenths of American highway bridges are built with floors of wooden plank, which give the structure so little dead load that a light carriage moving across at a trot sets the truss members rattling. These plank floors rapidly wear out and rot out, and are a continual source of expense and even of danger. Why not thicken the truss member sections a little and carry the paving or macadam right across the bridge, as is the general practice on all bridges abroad and on city bridges in this country? The dead load acts like an anvil to absorb the blows of wheels and hoofs, and the bridge is held down to its work.

But in making this change we must be careful not to run into the other difficulty of spreading more ironwork to the weather for corrosion to do its work upon. Some of the solid-floor railway bridge work which has been carried out in recent years is open to serious criticism on this score. Iron plates covered up with ballast cannot be painted and protected from corrosion, nor can the extent to which corrosion goes on be watched. What the life of these so-called permanent structures will be is a problem that deserves more consideration than it seems to have received.

It will be apparent to the attentive reader that what we have said applies chiefly to the structures of moderate span; but on all bridges built in iron or steel at the present day, whether large or small, the up-to-date designer is paying much more careful attention than formerly to the problem how to expose the least surface of metal to the action of the weather and how to guard his structure against vibration and destructive wear.

But the lessons of experience do not end here. The girder is better than the truss for short spans; but a structure which will require no painting, no inspection, no repairs, which involves no risk (or practically none in comparison with that which must exist on every structure of wood or metal), and whose life is so long that no provision need be made for its renewal—such a structure is the ideal toward which progressive engineers are looking, and which is rapidly meeting with increasing favor. Such a structure, we need hardly say, is the well-designed and well-built masonry arch, and we speak within bounds in saying that a very large proportion of the short-span bridge structures on railways and highways are likely to give place to masonry arches. Indeed, this work of substitution is already in progress, and on no small scale.

It should be said that the question is as much one of finance as of engineering—or rather let us say that the competent engineer changes his practice with changes in financial conditions. Time was—and still is in some parts of the country and under some conditions—when wooden trestles represented the best engineering practice. At other times, and in other places, the cheap, light truss and the heavy girder have each represented the best engineering work, and now the permanent masonry structure demands attention, as in some cases, the most advantageous solution of the engineer's problem.

There is a current idea, we believe, that the masonry arch is an expensive luxury, only to be afforded by wealthy corporations or communities. But this is true only to the extent that such bodies are able to borrow money at low rates of interest, and thus bring down the fixed charges on permanent work to so low a point that they offset the annual maintenance cost of a cheaper construction.

Let us make this point perfectly clear if possible; for we doubt not many of our readers will think we are talking nonsense, in speaking of a masonry arch as cheaper than a steel truss or girder bridge. To those who may hold such an opinion, we suggest that a careful estimate be made of all the items which enter into the cost of maintenance of an iron or steel bridge.

Painting, of course, stands first, and do we not speak within bounds when we say that engineers are getting tired of paint? It is an easy matter, perhaps, in the first ten years or so of a bridge's life, to keep rust in check by repeated paintings; but as the successive coats accumulate, there is more and more tendency to crack off from the metal, and the rust works underneath with discomforting rapidity. The engineer may require the old paint to be thoroughly removed before applying the new, in writing his specifications; but writing down the requirement doesn't remove the paint, and in practice the old paint is not and cannot be removed by hand. In recent years engineers, in the endeavor to obtain a clean iron surface on which to apply their paint, have been using sand-blast apparatus; but the cost of such work is almost prohibitory in any case, and is quite so on small bridges where the cost of setting up the plant becomes a large part of the total. Even when the work is done we are merely back at the beginning, and the accumulation of another load of paint skins begins which will again require removal some day—if the structure stands long enough.

Again, there is the matter of inspection and repairs. Loose rivets must be detected and replaced. Evidences of wear or dangerous strains at any point must be watched for. Guard rails and timbers must be provided, and renewed as they become weakened by decay. All these items mean not only expense, but risk. For whenever safety is made to depend on some one's vigilance, there is always a chance that the vigilance may be relaxed at the wrong moment. As an illustration, recall that fatal accident on the Boston & Albany R. R., at Chester, Mass., in 1893, in which 17 persons lost their lives and 32 were seriously injured, all through the carelessness of a gang of bridge repairers. Of course, such accidents are rare, but when they do occur there is a heavy bill for damages to be settled. Thus it is that the item of risk can also be expressed in dollars and cents, and it ought to be given due weight in any careful calculation.

Finally, to the annual cost of maintenance of the iron or steel structure, and the risk which it involves, we must add an amount which, placed at compound interest, will suffice to replace the structure at the end of its life. This, of course, raises the question, what is the life of a steel bridge? Some have been replaced in not more than 25 to 30 years. At the other extreme are the large structures built with heavy-sectioned members throughout, and which with proper care seem good for a century at the very least. It is the small short-span structures on which wear and rust do the quickest work, and it is, of course, this class of structure that the masonry arch is best fitted to replace.

Having computed now the total annual charge against the iron or steel bridge, we have next to find the amount by which the masonry arch will exceed it in first cost. Then compare the annual interest at prevailing rates on this excess of cost of the masonry arch with the total annual charge on the metal bridge and we know at once which is actually in the long run the cheaper of the two.

The extension of the use of concrete has given a great impetus to the use of the masonry arch. Suitable cut stone for an arch ring is often only to be had by shipment over long distances, and at best it is very expensive, especially when the arch is skewed or of any unusual form. Stone-cutting machinery has done something to reduce the cost, but it has been more than offset by the increase of wages through the stone workers' unions. Concrete, on the other hand, costs no more for a cubic yard when dumped in the forms for an arch ring than when dumped in a foundation, where its use has long been so familiar, and it is as easy to make a skew arch as a straight one. The use of steel members in connection with it, moreover, greatly increases its strength and homogeneity and decreases the risk of cracks forming in the ring in a plane which may cause the arch to fail by shearing. With a properly constructed concrete-steel arch, ample strength may be secured with remarkable lightness and at a total cost so small as to make it a much more formidable competitor of the iron bridge than any cut-stone masonry structure could be.

Yet with all the advantages of the concrete arch, a word of caution may not be amiss. With the monolithic concrete arch unyielding foundations must be provided to receive the arch thrust, or settlement will occur, the crown of the arch will settle and cracks will have to take place. An arch ring is immensely strong against the strains it is meant to carry, but it cannot change its shape. With an arch with cut-stone voussoirs such yielding is bad enough, but it is worse in a monolithic arch ring, for there is no telling in what plane a crack may form, and the combined shearing and bending forces may even cause the failure of the structure.

It is easy to say that this difficulty should be met by providing secure foundations; but every engineer knows that bridges must be built where no solid foundations are financially possible. In fact, the cases are exceptional where solid rock is at hand to receive the thrust of an arch skewback.

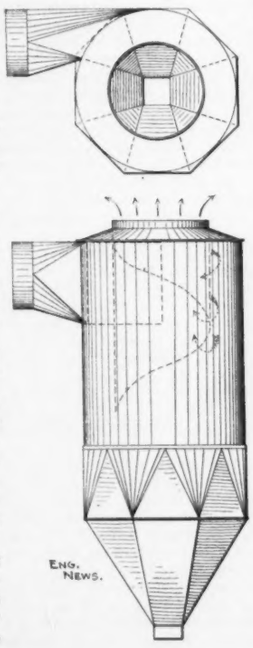
To meet this difficulty European engineers have for several years been introducing hinges at the crown and at the springing line of the arch. An example of a Spanish bridge about to be constructed in this way is presented on another page of this issue, and numerous other bridges of this type have been shown from time to time in this journal. No American engineer, however, has thus

The actual construction chamber, in the rear of the shield, is included between the front transverse bulkheads, and a temporary transverse wall of masonry situated some distance in the rear of the shield, and fitted with two air-locks—one for men and the other for materials. The steel rings are mounted under the rear of the shield, and the outside cement is rammed in place, the diameter of the cylindrical shield-hood being large enough to admit this cement over the rings. This outer coating of cement also seals the working chamber against the sand and water outside. The shield is pushed forward by 16 hydraulic rams, abutting against the last steel ring put into place, in the usual manner.

This tunnel was commenced in February, 1896, and was finished in February, 1899. But, after finishing 525 ft. of the tunnel the work was interrupted for one year. It was finished without any serious accident, and a tunnel of similar design and 6,560 ft. long is now under construction at Hamburg.

A CENTRIFUGAL SEPARATOR FOR SHAVINGS AND DUST.

The old-time method of separating dust from a moving current of air was to pass the current into a large settling chamber where the dust would gradually sink to the bottom. In the case of dust composed of inflammable materials, however, such as flour or sugar, such dust chambers became a dangerous feature; the mixture of dust and air was almost as explosive as a mixture of illuminating gas and air, and serious explosions are said to have been caused by sparks reaching the contents of such dust chambers.



Elevation and Plan of Centrifugal Separator for Shavings and Dust.
The Buffalo Forge Co., Buffalo, N. Y., Makers.

To obviate this, centrifugal separators have been devised, in which the current of mingled dust and air is given a rapid rotary movement, and the particles of dust are carried by their centrifugal force against the wall of the chamber. The air enters the separator in a tangential direction at the top and passes out centrally. Such separators occupy trifling room compared with the old-time settling chamber and greatly diminish the risk of fire or explosion.

The accompanying cut illustrates a separator of this type put on the market by the Buffalo Forge Co., of Buffalo, N. Y., designed especially for use in woodworking establishments where shavings, sawdust, etc., are removed by an air blast from the machinery and carried in chutes to the boiler-room or other place of deposit. As we have indicated above, the principle is not a new one, but its application is by no means as well known as it deserves to be among engineers, and we have, therefore, taken space to illustrate this example of its use.

CIVIL SERVICE EXAMINATION FOR SUPERINTENDENT OF WATER-WORKS AT COLUMBUS, O.

An interesting set of questions was propounded, a few weeks ago, to six applicants for the position of superintendent of water-works at Columbus, O. The examination was oral, and the answers were taken by a stenographer. The examination was conducted in behalf of the civil service commission by a special commission of three engineers, as follows: Messrs. John Zuber, Ex-Deputy Director Department Public Improvements; Prof. W. A. Knight, M. E., Asst. Prof. Machine Shop Practice, Ohio State University; and Wm. Michel, Engineer Maintenance of Way, Hocking Valley Railroad. The technical questions were as follows:

EXECUTIVE AND GENERAL.—From what source does the West Side pumping station derive its water supply? From what source is the East Side pumping station supplied with water? What experience have you had in handling men? What experience have you had in running stationary engines? Name the different classes of men employed in the water-works department? What are the duties of the tapper? What are the duties of the service inspector? Do you consider it advisable to encourage the use of water meters in this city? Give reasons. What remedy would you suggest for the reckless wastage of water? In what manner, in your opinion, could the city of Columbus obtain an adequate supply of good water for present and future needs?

PUMPING ENGINES AND BOILERS.—How is the capacity of a pumping engine usually stated? What is the usual method of determining the amount of water pumped? Is there any error in such a method? What is meant by slippage? What is the allowable slippage in a first-class pumping engine? How could it be determined? What is meant by the duty of a pumping engine? What purpose does the determination of duty serve? What should be the duty of a first-class pumping engine and how is it determined? Which should be, under proper conditions, the more economical, a simple, compound, or triple expansion engine? Explain. There is a triple expansion engine at the East Side station and a compound at the West Side station. The reports of the superintendent of water-works show a higher duty for the West Side than for the East Side engines. Can you offer any explanation of this fact and suggest a remedy? What are the advantages and disadvantages of water-tube against fire-tube boilers? About what amount of water should be evaporated per pound of coal in each type of boilers? Explain the principle of the injector? Name some of the modern appliances used in connection with steam boilers? Explain each of the following terms, give causes for, and tell their effects on a boiler: Internal corrosion, external corrosion, pitting, grooving, incrustation.

HYDRAULICS.—What is the weight and volume in cubic inches of one gallon of fresh water? How do you compute the capacity of a pumping engine? What is the theoretical height that a pump will lift water at sea level. Why is this the limit? What is considered a good practical distance to lift water? How would you reference a pipe line and valves so that they could be found at any time? How do you find the end area of a pipe? What is the present market price per ton of new cast-iron water pipe? Of scrap cast-iron water pipe? What pressure per square inch are water pipes tested at the foundry before shipping to the market? Will a pump lift hot water as readily as cold? Why? What causes water hammer in water pipes? Its effects? Would you consider it good practice to tap a 4-in. cast pipe for a 2-in. service pipe? Why?

IRRIGATION IN THE NILE VALLEY, AND ITS FUTURE.*

By W. Willcocks, C. M. G., M. Inst. C. E.†

As Horace compared the works of Pindar to the sustained flight of an eagle, and contrasted with them his own poems, which he compared to the cells of honey built up industriously by bees, so may the historical irrigation of the Nile Valley be contrasted with the patient labor of perennial irrigation. That basin irrigation which has for upwards of 7,000 years held its course unimpeded and unchecked may well take its place by the eagle's side during her most daring and sustained flight. The intricacies and lesser details of basin irrigation can be mastered by any one who will make a methodical study of my book on "Egyptian Irrigation," and I shall therefore only give in this paper the main features, and draw such lessons from them that others may be encouraged to learn the wisdom of the ancient Egyptians, and apply their knowledge of those new countries which have become the heritage of the European races, and whose permanent development can be secured by irrigation, and by irrigation alone.

Basin irrigation, as it has been practised in Egypt for thousands of years, is the most efficacious method of utilizing existing means of irrigation which the world has witnessed. It can be started by the sparsest of populations. It will support in wealth a multitude of people. King Menes made his first dike when the Egyptian nation was in its infancy. Egypt, in Roman times, supported a population twice as dense as that of to-day. The direct labor of cultivation is reduced to an absolute minimum. Shakespeare's genius has crystallized the system for all time:

> They take the flow o' the Nile
> By certain scales in the Pyramid; they know,
> By the height, the lowness, or the mean, if dearth
> Or foizon follow; the higher Nilus swells,
> The more it promises; as it ebbs, the seedsman
> Upon the slime and ooze scatters his grain,
> And shortly comes to harvest.

How many undeveloped countries are there to-day whose rivers in flood run liquid gold which is never utilized? Taking my stand at Koshesha, on the earliest of the Egyptian dykes, I have often longed for the day when it might be my privilege to introduce into some new country this wonderful irrigation of ancient Egypt, and, like the engineer who gave undying fame to the name of Menes, give wealth and prosperity to some hitherto poor and barren land. How many thousands of modern pilgrims visit this strangely interesting land of Egypt, and go back to their homes with fragments of mummies, old pottery, and useless antiquities, and yet never carry away with them the secret by which that most ancient country renews its youth each recurring year.

THE ORIGIN OF BASIN IRRIGATION IN EGYPT.

If we cast back our view to the dawn of Egyptian history, we can picture the Nile Valley as consisting of arid plains, sand dunes and marshy jungles with reclaimed inclosures on all the highest lands. Every eight or ten years the valley was swept by a mighty inundation. We may well imagine with what awe the ancient Egyptians contemplated laying their hands on the great river, and saying to it, "Thus far and no farther." The seeds of future success lay in the resolve of King Menes' engineers to confine their attention to one bank of the river alone. It was the left bank of the river which history tells us was first reclaimed. A longitudinal dyke was run parallel to the stream, and cross-dykes tied it to the Lybian hills. Into these basins or compartments the turbid waters of the flood were led by natural water courses and artificial canals; and meantime the whole of the right bank, and the trough of the river itself, were allowed to be swept by the floods. It must have been on this wild eastern bank that were conducted all the hippopotamus hunts which are crowded on the wall pictures of buildings of the early dynasties.

In all probability the first six dynasties contented themselves with developing the left bank of the Nile. As, however, the population increased, and with it the demand for new lands, it became necessary to reclaim the right bank of the river as well. The task now was doubly difficult, as the river had to be confined to its own trough. This masterful feat was performed by the great Pharaohs of the twelfth dynasty, the Amenemhats and the Usartsens, who, under the name of Sesostris, usurped the place of Menes in the imagination of the ancient world. They were too well advised to content themselves with repeating on the right bank what Menes had done on the left. By suddenly confining the river they would have exposed the low-lying nomes of Memphis and Lower Egypt to disastrous inundations. To obviate this they widened and deepened the natural channel which led to the Fayoum depression in the Lybian hills, and converted it into a powerful escape to carry off the excess waters of high floods; and so successful were they in their undertakings that the conversion of the Fayoum depression into Lake Moeris was long considered by the ancient world as one of its greatest wonders. They led the flood into the depression when it was dangerously high, and provided for its return to the river when the inundation had come to an end. By this means they insured the lake against being at a high level during a period of flood. The gigantic dykes of entry and exit were only cut in times of emergency, and were reconstructed again at an expense of labor which even an Egyptian Pharaoh considered excessive. To understand how capable Lake Moeris was to control the floods and turn a dangerous into a beneficial inundation, I should recommend a study of Major Brown's "Fayoum and Lake Moeris."

As years rolled on the Nile widened and deepened its own trough, to which it was now confined; and eventually the time came when Lake Moeris could be dispensed with without danger. It was gradually reclaimed and converted into a province. It was owing to this early development of the left bank of the Nile that all the ancient dynasties had their capitals on that side of the river; and it was possibly the rapid increase of wealth in the hands of the bolder people who first settled on the right bank which gave the later government of the country into the hands of the Theban nobles. This is only conjecture, but in the hands of true Egyptologists it may be of use in the study of those old-world events.

Basin irrigation holds the flood waters for some 45 days per annum over the whole of the valley. The water is in places 10 ft. deep, and in others only 1 ft. deep, while the average depth is about 4 ft. Now, the retention of this water over the land for a period of six weeks permits of the thorough saturation of the subsoil, in places where the subsoil is of proper consistency; and this water can be drawn on, in winter and summer, for maturing certain crops and growing others. It was where the subsoil gave a plentiful supply of water, and permitted of intense cultivation throughout the year, that we find all the ancient capitals of Egypt. Abydos has the finest subsoil water in

*Paper read before the International Engineering Congress at Glasgow, in Section II.: Waterways and Maritime Works.

†Late Director-General of Reservoirs, Egypt.

far adopted hinges for a masonry arch, and there appears to be a prejudice in this country against their use. It seems to be thought that the hinged construction is one of those complicated details designed with a view to abstruse theoretical considerations, of which European engineers are so prolific.

We believe this is an incorrect view of the matter. The ordinary masonry arch is built and must be built with an enormous excess of strength on account of the impossibility of accurately computing the stresses in it. By the introduction of hinges, however, the stresses in the arch can be accurately determined, and it becomes possible to considerably lighten the structure and reduce by so much the load on the foundations. The anxious time in the construction of an ordinary arch is when the centers are removed and the arch takes up its load. In any flat arch construction, and most long-span arches must be of this form, a very slight yielding of the skewbacks means a considerable drop at the crown, and an arch without hinges cannot suffer such a change of shape without trouble. The hinged arch, however, can adjust itself to its load without the least danger, and the trouble, anxiety and expense now incurred to obtain unyielding foundations are greatly reduced.

It is objected to the hinged arch that the hinges cost as much as the additional material that they save, and also that an arch with hinges is objectionable from an æsthetic point of view. It is doubtful whether either of these objections are necessarily valid. Certainly it ought to be possible to design a hinge construction which should be at once inexpensive and effective; and in an arch with granite hinges the hinged construction is hardly noticeable.

Another idea which occurs to us in this connection is that the hinges may even be temporary, where their sole purpose is to permit the safe settlement of the arch when the centers are struck. After the arch has taken its load and assumed its final form, and compression of its foundations is believed to have ended, the hinges may be filled solid with concrete. In this way another objection brought against the hinged arch, viz., the expense and difficulty of maintaining the hinges in operative condition would be met.

We make this matter thus prominent in view of the rapidly-increasing use of the masonry arch in this country, and in the belief that the advantages of the hinged arch have not yet been properly appreciated by American engineers. It is, of course, true that nearly all the concrete arches thus far built in this country have been of moderate span and heavy construction. If American engineers are to follow the lead of European engineers in the construction of light, long-span arches, they must adopt a hinged construction to insure an equal success. It is only such light, low cost structures, moreover, that can successfully compete with the truss or girder bridge, whose faults and failings we have set forth above.

LETTERS TO THE EDITOR.

An Indexing System for a City Engineer's Office.

Sir: I was much interested in the article on indexing railway maps and drawings in the Engineering News of Sept. 5. Thinking it might be of some interest, I send you herewith a copy of the index scheme as used in the city engineer's office at Jamestown, N. Y. The idea is the same, but the application is somewhat different.

For indexing pamphlets, scraps and engineering journals I have for many years used the Dewey system of classification (somewhat expanded in the engineering sections) so extensively adopted in libraries.

Yours truly, F. W. Dalrymple, City Engineer.

Jamestown, N. Y., Sept. 16, 1901.

(The general plan followed at Jamestown is illustrated by the main divisions and subdivisions, given below.—Ed.)

00 General information.
100 Drawings on file.
200 Note books of surveys and levels.
300 Note books of estimates, calculations, etc.
400 Sewer inspectors' note books.
500 Diagrams, tables, tests, etc.
600 Council proceedings.
700 Papers and letters on file in the office.
800 Bills for work done by the city.
900

The subdivisions will be as follows:

0 The general subject arranged alphabetically.
10 Streets.
20 Paving.
30 Sewers.
40 Municipal ownership of public utilities.
50 Private ownership of public utilities.
60 Allotments, subdivisions of property.
70 Buildings, bridges, culverts, etc.
80 Streams and lake.

All subjects can be arranged as follows by adding the proper decimal.

.01 Reports.
.02 Costs, complete.
.03 Preliminary estimates.
.04 Final and partial estimates.
.05 Assessments.
.06 Bids.
.07
.08
.09 Calculations, computations, etc.

Stresses on Dams Due to Impact.

Sir: In your issue of Sept. 5 Mr. John S. Fielding criticises one statement made in my article which appeared in your issue of May 30 relative to the Austin Dam failure. Mr. Fielding maintains that there is a greater pressure upon the center of a dam than at the ends, due to greater velocity of water; but I observe that now he does not consider the pressure developed by impinging water, but by impinging debris, which entered not at all into the Austin Dam discussion, as there was over 11 ft. of water over the crest, making it impossible for debris to strike the dam.

Mr. Fielding has seen an immense log jam in the Ohio River, and Mr. Fielding would have us infer that a great jam of logs might move en masse upon a dam and sweep it out of existence by virtue of its inertia. Jams above dams do not form in that way. Little by little the logs accumulate, each striking with force, but with force negligible as a unit, so far as overturning of the dam is concerned. In the course of hours, or it may be days, a jam extending from shore to shore may exist, but that the pressure so developed is comparatively slight is well illustrated when a large jam occurs above a comparatively small bridge pier without pushing the pier over, a phenomena that most engineers have seen.

Of pressure developed by ice, the very same reasoning holds good. If ice suddenly broke up from some lake in the spring and moving in a majestic mass unbroken till it reached a dam with no more water over its crest than enough to prevent the ice from passing, then Mr. Fielding's reasoning might have a little weight. As a rule, however, when ice moves it is in separate cakes and not en masse. Whoever saw a solid floe—solid, remember—200 ft. long, moving 10 ft. a second (over 9 miles an hour) against the face of a dam? Even were such an unheard of thing to occur, the ice would crush under the pressure upon striking the dam and thus cushion the shock. Mr. Fielding's hypothetical kinetic, 2,062,500 ft. lbs., have no meaning whatever in this problem, which is one of statics.

Yours truly,
Halbert Powers Gillette.

Rochester, N. Y., Sept. 6, 1901.

Notes and Queries.

"Student," Toronto, Ont., writes:

It is proposed to build a range of cattle sheds 10 ft. high, 20 ft. wide, and about 50 ft. long, the walls to be of concrete. In the event of its being desired to extend the length of the sheds at a later date will there be any difficulty in effecting a good junction of the old with the new walls? What is the cheapest form of roofing for buildings of this width? Warmth being a sine qua non.

(With careful work there should be no difficulty in bonding the new concrete wall to the old. An ordinary wooden roof with the space between the rafters and the chord connecting their feet used for storing fodder, would seem to suit Canadian conditions as well as anything that could be devised.)

TESTS OF STEAM TURBINES direct-connected to dynamos are described in a paper read before the Glasgow International Engineering Congress by Hon. Chas. A. Parsons, the inventor of the Parsons turbine, and Mr. G. G. Stoney, of Newcastle-on-Tyne, England. The first steam turbine of considerable size was built in 1892. It was coupled to a 100-K-W. alternator, and when using moderately superheated steam of 100 lbs. pressure it showed an economy of 27 lbs. steam per K-W. hour. Tests of 500-K-W. units recently made have shown results of 21 to 26 lbs. per K-W. hour. The reduction in steam consumption with 50° superheating is about 8% and with 100° about 12%. It is also found that every additional inch of vacuum above 25 to 26 ins. reduces the steam consumption about 4%. It has been found that in steam turbines the steam consumption closely follows a right line law, or is proportional to the load plus a constant quantity, which represents the consumption of steam at no load. In connection with superheated steam, it may be mentioned that as there is no internal lubrication of the turbines, none of the usual difficulties which occur with reciprocating engines are met with in its employment. The absence of internal lubrication renders the exhaust steam absolutely free from oil, so that the water from the hot well can be returned to the boilers direct without oil filters. Special tests have been made from time to time on turbine engines to verify the statement that no increase in steam consumption occurs with the age of the plant under fair wear and tear. In non-condensing plants also many tests have been made, but, as will be expected, the steam turbine compares rather more favorably with the reciprocating engine in condensing types. In a 100-K-W. size a consumption of 39 lbs. per K-W. hour has been attained, and in a 250-K-W. turbo-dynamo 38 lbs. per K-W. hour, both with about 130 lbs. steam pressure and no superheat. In larger sizes of 1,500 K-W., with 200 lbs. steam pressure and 150° F. superheat, a consumption of 28½ lbs. per K-W. hour non-condensing has been guaranteed and is expected to be easily attained, if not surpassed.

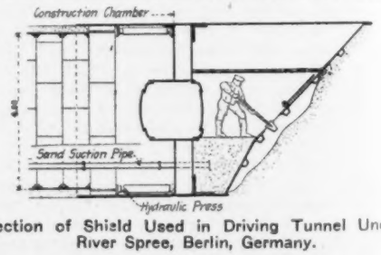
AMERICAN TOOLS WOULD SELL IN FRANCE, says U. S. Consul Albion W. Tourgee, of Bordeaux, in a personal letter to this journal. But he also says that the French dealer has no eye for novelties, and a demand must be created before the dealer will supply himself with the articles wanted. This cannot be done through wholesale dealers, or by advertising in French trade journals. Mr. Tourgee suggests the scattering of descriptive catalogues of tools and implements, printed in French, among the carpenters, cabinetmakers, etc. He says the tools used by the French artisans are much inferior to American tools, and is confident that these workers would demand the better ones if they knew their merits. The method suggested for introducing goods is slow and somewhat uncertain in the matter of immediate profits, but it is the plan pursued by our most active industrial competitors. Booklets or circulars in anything but the French language would be wasted in France.

TUNNEL THROUGH SAND, UNDER THE RIVER SPREE, AT BERLIN.

Among the exhibits of the public works of Germany at the late Paris Exposition, was matter relating to a tunnel for a tramway under the River Spree, at Berlin. This tunnel is driven through mud and sand heavily charged with water. The total length of the tunnel is 2,017.2 ft., of which 1,490.3 ft. are tunnel proper; the grade of the tunnel lies 39.36 ft. below the mean level of the river, and the least thickness of soil between the top of the tunnel and the bottom of the Spree is about 10 ft.

The tunnel is formed of a cast-steel cylindrical shell 4 m., or 13.12 ft. in diameter, made in rings and covered with cement mortar both inside and outside. The exterior layer of mortar is 3⅛ ins. thick, and the inside layer, 4¾ ins. thick. At the bottom of the tunnel is a concrete floor, carrying the rails, and also a drain for taking away any water that may filter into the tunnel. The cylinder rings are 2.13 and 1.64 ft. wide; and they are each made of nine plates fitted on all four sides of each plate with inside flanges for bolting together. Between these rings, during erection, flat steel circles are bolted, projecting outward and thus increasing the rigidity of the metallic tube.

The actual excavation is done with an advancing shield and under compressed air. The shield is made of a double, transverse bulkhead, enveloped in a cylindrical hood; the front of this hood being



Section of Shield Used in Driving Tunnel Under River Spree, Berlin, Germany.

cut away on an angle of 45° to protect the men at work. As shown in the illustration, this hood is closed on the oblique front by a metal covering, provided with hinged doors, which may be opened at will. The material removed through these doors is thrown into the bottom part of the hood, and is then removed by a sand-pump, with its pipes passing through the transverse bulkhead, at the bottom. This advance hood is closed in the upper part so that a space filled with air is left as a refuge for the workmen in the case of a sudden inflow of sand and water. For the same purpose the air-lock is placed in the bulkhead which separates the working chamber from the space to the rear of the shield, in which the rings are being built up.

has 111 openings of 16 ft., and of the Ibrahimin canal head, which is to discharge 20,000 cu. ft. per second in flood. No one who has not had personal experience of such works can conceive the labor, ingenuity and skill needed to lay 300,000 sq. ft. of floor in the bed of a river 16 ft. below the water level on a sandy foundation honeycombed with springs, whose action is aggravated by each hour of delay. At Zifta, where the barrage has 51 openings of 16 ft., Mr. Hurley is the resident engineer. The latter is under Major Brown, Inspector-General of Lower Egypt, while the Assiout barrage, with the Assuân dam, is under the charge of Mr. A. Webb, Director-General of Reservoirs.

Egypt proper consists of 6,000,000 acres of cultivable land. Of this area 4,000,000 acres are rented at a mean value of £5 per acre per annum and 2,000,000 acres at a mean rental of £1 per annum. Practically one-third of the country is undeveloped, because the summer supply of the Nile, which is the keystone of perennial irrigation, is not sufficient. The way in which the irrigation department, under the guidance of Sir William Garstin, who succeeded Sir Colin Scott-Moncrieff, has stretched the existing supply by skilful rotations would make one believe that water was an elastic substance, but the farthest limit has been reached. To develop Egypt as she can be developed we require reservoirs capable of supplying annually 200,000 million or 200 milliards of cu. ft. of water. This would mean an additional discharge of 20,000 cu. ft. per second in summer and an increase to the renting value of Egypt of £6,000,000 per annum. This increase would represent a capitalized value of £60,000,000. In other words, each milliard of cubic feet of water supplied to Egypt is worth £300,000.

THE ASSUAN DAM.

As the Nile has been at the bottom of everything in Egypt, be it the dethroning of a viceroy to whose charge were laid the disastrous floods of 1877 and 1878, or the success of an occupation, so the disastrous summer supplies of 1888 and 1889 decided the question of reservoirs. Sir Colin Scott-Moncrieff appointed me Director-General of Reservoirs, with four years within which to prepare the projects. The superior staff consisted of Messrs. Hewat, Roux, Clifton, Stent, Rushdy Bey, Hassib Effendi, Saber Effendi and Balig Effendi. We examined all the sites available in Egypt, and finally decided on the Assuân Cataract as the true site for a reservoir dam. After examining the question in every aspect, I came to the conclusion that no existing dam of any kind would avail on a river like the Nile, with turbid floods of long duration. No ordinary scouring sluices or spill channels would prevent the obliteration of the reservoir in a few years and its conversion into a cultivable plain. I therefore decided on a type of dam hitherto untried, but which I felt confident would meet the requirements. I proposed piercing the dam with openings capable of discharging the whole Nile flood in its strength, and providing these openings with suitable regulating gates so that the comparatively clear winter waters might be impounded for use in summer. With my mind made up on this point, I traveled over Europe searching for suitable gates. At Bologna I met Signor Benetti, who aided me considerably in my studies, and to whose guidance I subsequently owed much. In Ireland and on the Manchester Ship Canal I at last found the gates which would suit the kind of dam I had proposed, namely, Stoney's self-balanced roller gates. The design could now be proceeded with. The proposed dam was capable of holding up 85 milliards of cubic feet of water, and at the same time passing the maximum Nile floods of 475,000 cu. ft. per second.

Before proceeding further with the work, Sir William Garstin decided on an International Commission visiting Egypt and giving its opinion on my proposals. The commission consisted of Sir Benjamin Baker, M. Boulé and Signor Torricelli. They approved of the site and the type of dam, with reserves about Philae Temple, which lay on a low island up-stream of the proposed work. They proposed changes in the alinement, which I accepted. The original design followed a crooked line, but rested on the best rock at the cataract. The new alinement was a straight line, cutting off corners. My original line was the better one, and in future works I should strongly advise engineers to sacrifice appearance to good rock wherever they find it. The commission, especially Signor Torricelli, insisted on very severe conditions of theoretical pressure and stability. These I accepted with avidity, as they enabled me to re-design the dam on much more solid lines, and thus, when the government, buoyed up by a succession of good summers, yielded weakly to the sentimentalists on the question of Philae Temple, and insisted on the dam being reduced to a height which would only impound 35 instead of 85 milliards of cubic feet of water, I was able to design a dam which could afterwards be raised and impound 70 milliards of cubic feet of water. The Egyptian Government has a dam at Assuân nominally capable of holding up 35 milliards of cubic feet of water, but actually capable of holding up 70 milliards. These additional 35 milliards of cubic feet of water will be worth £10,000,000, and will be at the disposal of Egypt whenever she wishes to add a few feet to the top of the dam and spend some £250,000. The reservoir is described in my report on "Perennial Irrigation and Flood Protection," printed by the Egyptian Government in 1894, and in my report of 1895. It is also given in "Egyptian Irrigation."

The Assuân dam is a solid wall of granite masonry, pierced by 140 under sluices of 23 ft. by 6½ ft. and 40 upper sluices of 11½ ft. by 6½ ft. The total area of waterway is 24,000 sq. ft. The greatest height of dam will be 130 ft., and the final head of water will be 85 ft. The maximum flood of 475,000 cu. ft. per second will be discharged at a velocity of 20 ft. per second, and ordinary floods at a velocity of 16 ft. per second. Of the openings 110 will be lined with granite ashlar and 30 with cast-iron. The regulation will be performed by Stoney's self-balanced roller gates.

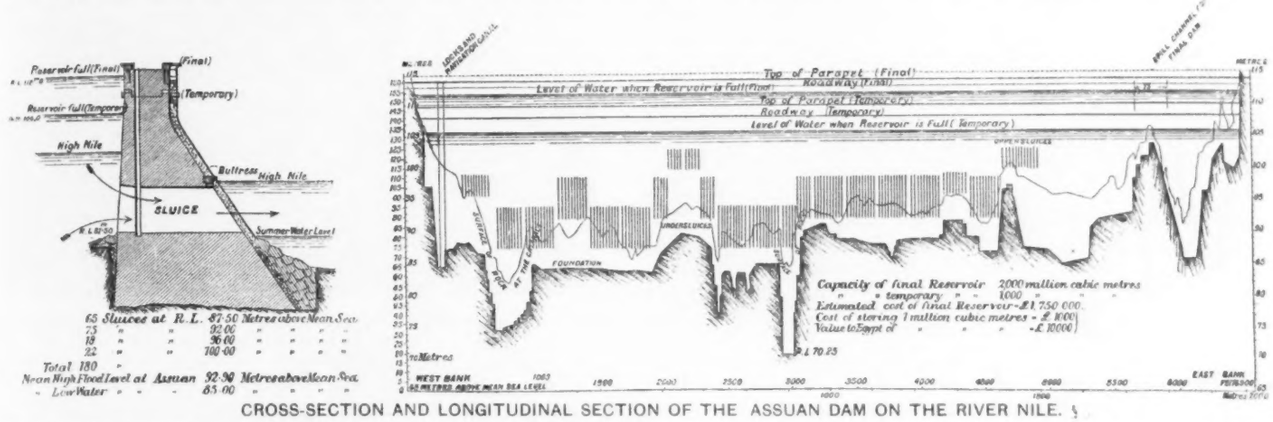
As the International Commission, which controls the finances of Egypt, refused to sanction the funds for building the Assuân dam and the Assiout weir, Lord Cromer arranged with Sir Ernest Cassel, who provided the funds, and with Sir John Aird & Co. as contractors, and Sir Benjamin Baker as consulting engineer, undertook their completion in five years. The Nile has so far looked kindly on the majestic work which is being built across it, and has given an unprecedented series of good seasons for its timely completion. On my leaving the Egyptian service, Mr. Wilson was made Director-General of Reservoirs, and on his death, last summer, Mr. Webb took his place. Mr. Maurice Fitzmaurice, the resident engineer, has allowed no questions of expediency or expenditure to interfere with his resolve to reach such rock as he considers suitable; and though his action has added some hundreds of thousands of pounds to the cost of the work, Egypt can only congratulate herself on the expenditure and on his presence at the dam. Sir John Aird & Co. are represented at Assuân by Mr. John A. C. Blue, another man as hard as the granite he works with.

The dam, if built by government agency to its full height, would have cost, with all its additional foundation masonry, £1,750,000, and have been capable of impounding 70 milliards of cubic feet of water. Each milliard of cubic feet of water would therefore have cost £25,000, and been worth £300,000. As the schedule of rates by which the contractors are being paid is not in the hands of the public, no estimate of actual cost can be made.

THE PROBLEM OF WATER STORAGE.

From now on the whole of Egypt will be gradually changed from basin to perennial irrigation; and we shall be confronted with the very problems which Menes and the Pharaohs of the twelfth dynasty solved. It would not be unwise to follow their example, and first convert one bank and then the other to perennial irrigation; and when the time came to endow the whole country with the superior class of irrigation, attention might be directed to another depression in the Lybian deserts, which would be to the modern irrigation of Egypt what Lake Moeris was to the ancient. South of the Fayoum lies the depression known as the Wady Rayan, and connected with the name of Mr. Cope Whitehouse. If this were put in communication with the Nile Valley in the same manner as Lake Moeris, I have calculated that an expenditure of £3,000,000 would suffice for the works. It may, however, be found possible to utilize the excess waters of the Atbara River, by the aid of weirs, for the irrigation of extensive tracts which are now desert; and in the same way to utilize the Blue Nile for the Sennaar and Merse doabs, as we should say in India, or geziras, as they say in the Soudan. It must always be remembered that perennial irrigation requires only 1 cu. ft. per second per 100 acres, while basin irrigation requires five times as much, and, consequently, when basin irrigation is finally changed to perennial irrigation, Egypt will be able to dispose of a great part of her flood supplies, and, with suitable weirs and regulating works, be capable of thoroughly developing her new system of irrigation without any fear of inundations.

It was previously stated that Egypt needed 200 milliards of cubic feet of water, and that the Assuân dam could supply 70 milliards. The remaining 130 milliards must come from those vast lakes which constitute the sources of the Nile, and which to-day are in the possession of the English and Egyptian governments. In a paper entitled "Barrages and Collateral Works on the Nile," published in the Professional Papers of the Corps of Royal Engineers (Vol. XXVI., Paper VII., 1900, and in a pamphlet entitled "The Nile Reservoir Dam at Assuân, and After,"


Reservoir full (Final)
(Final)
(Temporary)
Reservoir full (Temporary)
High Nile
Buttress
High Nile
SLUICE
Summer Water Level
R.L. 87·50
63 Sluices at R.L. 87·50 Metres above Mean Sea
73 " " 92·00 " " " "
18 " " 96·00 " " " "
22 " " 100·00 " " " "
Total 180 "
Mean High Flood Level at Assuan 92·96 Metres above Mean Sea
" Low Water " " " 85·00 " " " "
Top of Parapet (Final)
Roadway (Final)
Level of Water when Reservoir is Full (Final)
Top of Parapet (Temporary)
Roadway (Temporary)
Level of Water when Reservoir is Full (Temporary)
UNDER SLUICES
FOUNDATION
Capacity of final Reservoir 2000 million cubic metres
" " temporary " - 1000 " " "
Estimated cost of final Reservoir - £1,750,000
Cost of storing 1 million cubic metres - £ 1000
Value to Egypt of " " " - £ 10000
R.L. 70·25
70 Metres
WEST BANK
EAST BANK

CROSS-SECTION AND LONGITUDINAL SECTION OF THE ASSUAN DAM ON THE RIVER NILE.

just published by Messrs. Spon & Co., I have explained in some detail how much can be done for Egypt by suitable works at the sources of the Nile. I shall here give the veriest outline of works which, in the not distant future, it will be the privilege of the Egyptian engineers to undertake.

If there are no political obstacles in the way, the Dembea or Tsana Lake in Abyssinia, at the source of the Blue Nile, with a surface of 1,000 square miles, and a reservoir capacity of 200 milliards of cubic feet of water, is a superb site for a reservoir. The water would course down to Egypt, and would be available for the whole of the rich-soiled Sennaar province south of Khartoum. Then we have Lakes Victoria and Albert Nyanza within the Uganda Protectorate, soon to be connected with the coast by a railway. Here we have lakes of 26,000 square miles and 1,500 square miles, respectively, with an immense reservoir capacity. I have contended for years that an expenditure of £1,000,000 would suffice to store enough water in these lakes to meet the requirements of the Nile Valley from Fashoda to the Mediterranean Sea, and to free the Blue Nile in summer for the sole use of the Sennaar Province. The only obstacle is the opening of a channel 1,500 ft. wide and 15 ft. deep through the peat marshes and swamps traversed by the White Nile in the sudd regions, and through which, at an expenditure of £15,000, Sir Reginald Wingate has opened a channel some 100 ft. wide. The work executed by Major Peak, which saved Egypt during the low summer of 1900, following the famine year of 1899, and endowed the country with £4,000,000 of cotton, is but the prelude to mighty undertakings in this region, which has been twice visited by Sir William Garstin since the reconquest of the Soudan, and where lies the great public work of the Egyptian Government of the twentieth century.

Discharges just taken by Sir William Garstin confirm the statements of all travelers through these dismal regions. It was found that over 10,000 cu. ft. per second were lost during the summer of this year. The existing channel was not capacious enough to carry on the outflow of the great lakes towards the north. The time cannot be far off when a score of dredgers at the north end, working southwards, will be cutting broad and deep channels through the poorly consistent peat-growths, which will burn like tinder when brought to the surface, and be scoured out like rubbish when once the waters are confined and have a head on them. Simultaneously with

the Nile Valley; Memphis has an excellent supply; while Thebes has the only good subsoil water on the whole of the right bank. Good subsoil water was to the ancient Egptian world what the presence of a rich gold mine is to one of our new colonies.

Subsoil water supplies the link between basin and perennial irrigation. It explains the reason why modern Egypt is not satisfied with the irrigation which has come down from the remotest antiquity, but is desirous of conferring on the length and breadth of the Nile Valley those advantages which gave Abydos, Memphis and Thebes their pre-eminence in the past. The thoroughly developed Nile Valley, with its permanent wealth and resources, may well betake itself to the more costly and remunerative methods of perennial irrigation; but for poor and undeveloped countries to leave the rich mines of wealth which the flood waters of their rivers are capable of supplying and to be turning their eyes to the unattainable irrigation from reservoirs and perennial sources is as unprofitable as was Naaman's longing for the clear streams of Abana and Pharpar, while the turbid waters of the Jordan in flood were alone available. Any country which possesses rivers and streams whose waters are in flood for six weeks per annum can betake itself to basin irrigation with more or less profit. The science of dams, weirs and regulators has received such development during recent years that there can be no problem so difficult that it cannot be solved by experience and originality. Basin irrigation, and basin irrigation alone, allows of the thorough development of countries whose streams have short and turbid floods; whether it be the stately irrigation of the Nile Valley, perfected by the science and experience of 7,000 years, or the less perfect but still highly developed and river-fed tank systems of Madras, or the primitive but effective basins of Bundelkund, where the impounded water irrigates the crops on the down-stream sides of the basins for one season and then allows of the basins themselves being dried and cultivated in the next.

The Nile in high flood rises 33 ft. above its bed, in a mean flood 30 ft., and in a poor flood 23 ft. The beds of the main basin canals are about 15 ft., and the cultivated land at the river's edge about 30 ft. above the river bed. The basins have an average area of 7,000 acres. Where the valley is narrow they average 2,000 acres each, and where it is wide 20,000 acres, while some of the tail basins are 40,000 acres in extent. Each canal has about seven or eight basins depending on it, of which the last is always the largest. There are masonry regulators at the canal heads, at each crossing of the cross banks, and at the tail escapes into the river. In the more perfect basins the canals and escapes syphon under one another and overlap and supply each other's deficiences, so as to meet the requirements of every kind of flood which Egypt can experience. Colonel Ross' work on the basin irrigation of Egypt, from which I have largely quoted in my book, is a monument of patient observation and a storehouse of information.

Some of the canals are veritable rivers, discharging 15,000 cu. ft. per second, but a good average canal discharges 1,000 cu. ft. per second. The largest canal has a width of 250 ft., while the average width is 30 ft. Good basin canals discharge in an average year 1 cu. ft. per second per 20 acres. Forty-five days suffice for a perfect irrigation. The cost of providing basin irrigation in Egypt for basins of 10,000 acres may be taken at £3 per acre, thus made up: Banks, £1 10s.; canals, 15s.; masonry works, 10s., and bank protection, 5s. If the basins are under 5,000 acres, the cost will be nearly double this. The annual cost of maintenance is 2s. per acre, while the lands themselves are rented at £3 per acre. In well irrigated basins no manures are needed, and alternate crops of cereals and legumins have been reaped for centuries without the land having been exhausted in any way whatever. Where the subsoil water is good and double cropping resorted to, there manures have to be applied.

THE CHANGE TO A PERENNIAL IRRIGATION SYSTEM.

The foundation stone of the conversion of the whole of Egypt from basin to perennial irrigation was laid by Mehemet Ali in 1833, when he began the construction of the barrages across the Nile branches north of Cairo. These weirs were intended to raise the summer level of the Nile 9 ft. As the ordinary summer level of the Nile was 5 ft. above its bed, the weirs were expected to raise it 14 ft. above the Nile bed. The old basin canals had to be considerably deepened to take in the summer supplies, while in other parts new perennial canals were dug. Perennial irrigation requires canals capable of discharging 1 cu. ft. per second per 100 acres, as against 20 acres for basin irrigation. Some of the perennial canals are very capacious. The two largest discharge 20,000 and 15,000 cu. ft. per second, respectively. There are no artificial canals in the world like them. All the canals are liberally provided with regulators and locks, but escapes are as a rule lamentably deficient. This deficiency of escapes causes silt deposits on an enormous scale, and is a serious blot on the irrigation system of the country. However, it is impossible to find the funds for taking up everything at once, and the energies of the irrigation department during the last ten years have been chiefly directed to the provision of sufficient drains to meet that over-saturation of the soil which all but the best regulated perennial irrigation invariably entails.

After many years' experience in India and Egypt, I am convinced that the construction of drains and escapes should precede, and not follow, the canals. It seems fatuous for engineers to be always over-saturating and half ruining tens of thousands of acres of low-lying lands during the improvement of hundreds of thousands of acres of high-lying lands, when it would be perfectly easy, with a little foresight, to secure all the advantages without piling up disadvantages. The drains have generally one-third the capacity of the canals. Dry crops require 1 cu. ft. per second per 100 acres, and rice requires the same per 66 acres. The drains in dry-cropped lands provide 1 cu. ft. per 300 acres, and in rice lands 1 cu. ft. per second per 200 acres. Surface drains are made wide rather than deep, as deep drains encourage weeds.

The Nile in flood is a very muddy river, and teaches its lesson with a relentless hand. To avoid silt deposits as much as possible, all canal heads are encouraged to take their flood waters from the top films, and not from the bottom ones, which carry most of the heavy silt. Canal heads which are placed below reaches of the river where the banks are being cut away and scoured silt up much more readily than those canals which start from well regulated and protected reaches. The sites of new canals are very carefully chosen in this respect. Wide, shallow canals and water courses silt less than deep and narrow ones. Great economies are made in silt clearances by those engineers who so grade their canals that the fall per mile of the first mile is greater than that of the second, and of the second than that of the third, and so on, until at the fifth or sixth mile the general slope of the canal is reached. The waters of the Nile flood, with a mean velocity of 2¼ ft. per second for mean depths of 12 ft., give only slight deposits on canals which start from well selected reaches of the river. These deposits, moreover, can be generally swept away by the comparatively clear supplies which follow the turbid floods.

Masonry regulators are given a depth of floor equal to half the head of water to be held up, though in the Nile a depth of 10 ft. is generally adopted, and in the main canals 7 ft. The ancient and modern Egyptians used vertical needles for regulation. The Egyptians were extraordinary skilful in handling the largest timbers. Needles of 30 ft. in length and 9 in. by 6 in. were commonly employed in 25 ft. depth of water. Nearly all these verticals have been displaced by horizontal sleepers and iron gates. Colonel Western and Mr. Reid introduced iron gates, and they are gradually supplanting the other systems. I prefer the vertical needles, and should use them wherever possible, except at canal heads.

Though all dry clearances are done by hand, at rates varying from 2d. to 3d. per cu. yd., all the wet clearances are performed by dredgers at a general rate of about 6d. per cu. yd. In the larger canals bucket dredgers are employed by preference. In the ordinary canals centrifugal sand or mud-pump dredgers are preferred. A long shoot deposits the material dredged into slurry pits, dug annually in the berms of the canals. If the soil is hard and stiff, grab dredgers are employed, though this form of dredger entails excessive wear and tear.

IRRIGATION AND FERTILIZATION.

It would be a healthy innovation indeed if the provision of suitable manures were to be considered as an essential part of a project for providing perennial irrigation. The day is not far distant, I believe, when governments which provide irrigation works will also provide manures, and sell the water and the manures together, one being as essential as the other. I know well from observation that a well-manured field needs only half the water that a poorly-manured field does, and in years of drought and scarcity manures almost take the place of irrigation. Why should there not be a manure rate as well as a water rate? Here in Egypt the numerous ruins of old-world cities have hitherto provided manure for a great part of the perennially irrigated lands, but these are being fast worked out and other sources must be sought for. Farmyard manure will never suffice for the intense cultivation in this country. In connection with this subject, I can recommend the study of a remarkably able paper on "Nile Cultivation and Nitrates" read by Mr. J. B. Fuller, C. I. E., before the Agricultural Society of England and embodied in the Third Series, Vol. VII., Part 4, 1896. Egypt possesses, in the vicinity of Luxor, natural beds of nitrates of unlimited extent, which come down to the river's edge. These nitrate beds have been used from time immemorial, but were brought to the notice of the general public by Mr. Floyer. They contain only about 3% of pure nitrates, but as they are on the edge of the Nile, in a perfectly cloudless and very dry country, it might be possible, with the aid of the plentiful supply of water always at hand, and powerful lenses, to concentrate the sun's rays and so hurry up the evaporation to profitably work the nitrates. The demand for nitrates is without limit in the Nile Valley, as Nile water, though rich in everything else, is exceedingly poor in nitrates. Here is an enterprise which the government should take upon itself, just as it takes upon itself the construction of reservoirs, but it will never be done until Egypt possesses an Under-Secretary of Agriculture of energy and real ability.

The perennial canals and collateral works have cost £4 10s. per acre, and the maintenance charges are 2s. per acre. The perennially irrigated lands are let at £5 per acre per annum.

IRRIGATION WEIRS AND DAMS.

I have purposely left the question of weirs till now, as it is connected with both basin and perennial irrigation. If it is possible, with skill and alinement, to lead the ordinary floods of a river into the basins, as it is generally possible on the Nile, no weirs are needed for basin irrigation. But even in Egypt the more thoughtful engineers, like Mr. Webb, are thinking of weirs for securing the perfect irrigation of the basins to the south of Abydos. Now, the raising of the summer level of a river 10 ft. or 12 ft. is being performed every day in many countries, but the raising of the flood levels of big rivers seven ft. is not easy to accomplish. The same permanent obstruction in a river which will raise its summer level by 12 ft. will barely suffice to raise a high flood by 1 ft. In Egypt we have two completed weirs capable of raising the summer level of the Nile, and we have two in existence and two under construction for raising the flood levels of the river. I shall speak later on of the type of dam or weir under construction at Assuân, which is capable of great development as a regulator of floods on the mightiest streams, and which, if suited to its purpose here, may one day be imitated on South African and Australian rivers.

When Sir Proby Cautley and Sir Arthur Cotton were planning and executing the gigantic irrigation works on the Ganges and the Kistna in Northern and Southern India, whose signal successes gave irrigation an impetus which nothing can now arrest, Egypt, too, under the guiding hands of Linant Pasha and Mongel Bey, was being gifted with works of great magnitude on the Nile. While, however, the Indian works were decided successes from their inception, the Egyptian weirs or barrages were at the beginning a conspicuous failure. Time, however, has more than justified the execution of the Nile barrages. When the partial failures first pronounced themselves the Egyptian Government needed one quality which it signally lacked, namely, courage to face the situation. Time went on and reports multiplied, as they always do in the hands of feeble men whose one idea of duty is the shirking of it, but no action was taken. Fortunately for Egypt, the British occupation of the country was followed by the advent of Sir Collin Scott-Moncrieff as Under-Secretary of Public Works. He was soon joined by the men who had learned their profession under him in India, and who counted it a high honor to work under his direction in Egypt. Though the element we were dealing with was water, we literally set the country ablaze. We made same mistakes and we secured many triumphs, but we went on conquering and to conquer. "Peace hath her victories no less renowned than war." Our chief possessed courage, that quality without which genius is cold, and opportunity never at hand.

One of our successes was the barrage. The barrages across the heads of the Rosetta and Damietta branches of the Nile are regulators rather than weirs. The floors are flush with the river bed, and consist of platforms of masonry 150 ft. wide and 11 ft. thick, with upstream aprons and down-stream pitching. The platforms support regulating bridges, with 16-ft. openings and piers 6¼ ft. wide. The roadway is 42 ft. above floor level. The Rosetta barrage has 61 openings and the Damietta barrage has 71. The Rosetta barrage has 20 openings too few, and the Damietta has 20 openings too many—but that is Egypt. Age cannot wither her, nor custom stale her infinite variety. The regulation is performed by three iron gates in each opening, raised and lowered by powerful traveling winches. The total height to which the water can be raised is 18 ft., but of this height 9 ft. are held up by the original barrages just described, and the remaining 9 ft. by subsidiary weirs recently constructed downstream from the old works.

The original barrages were designed and built by Mongel Bey. They long lay in neglect, but were tested and worked between 1884 and 1886, while they were under my charge. With Mr. Arnold Perry as resident engineer, the works were sufficiently repaired to hold up 10 ft. of water, and the government was encouraged to undertake their complete renewal under the direction of Colonel Western and Mr. Reid. Subsequent additions were made by Mr. Foster and Major Brown, and finally Major Brown designed and built the two subsidiary weirs, of which mention has already been made. The new weirs, constructed by Mr. Octavius Brooks as resident engineer, consist of solid cores of cement masonry 23 ft. deep and 10 ft. wide. On either side is a mass of clay 33 ft. wide and 6 ft. thick, overlaid by rubble stone 8 ft. thick and 50 ft. wide upstream and 150 ft. wide down-stream of the solid cores. Very possibly the surface pitching, which is of Cairo limestone, will have to be replaced by basalt blocks from the quarries to the northeast of Cairo. Major Brown is just bringing out a second edition of his "History of the Barrages," to which reference should be made for everything connected with the works.

I have already stated that the barrages are regulating bridges rather than weirs. They have been taken as types of the two new works of a similar kind under construction at Assiout, and at Zifta on the Damietta Branch. Both these works have masonry platforms 10 ft. in thickness, 90 ft. in length and flush with the river bed. They will be capable of holding up 10 ft. head of water in flood and 14 ft. head of water in summer. At Assiout Mr. Stephens is the resident engineer of the barrage, which

shaft, and also for the end connections, to be described. The shaft for communicating with the air chamber and for extracting the material, is located at the middle of the length of the caisson. The caisson is well slushed on the outside to assist in its descent, and is sunk to the bed rock in the usual manner.

FIG. 3. SINKING FOUNDATION CAISSONS FOR THE NEW YORK STOCK EXCHANGE BUILDING.

(The caisson in the foreground has the working chamber in place. The frame for setting caisson sections is seen at the left. The caisson in the rear has the air lock in position with the hoisting plant above.)

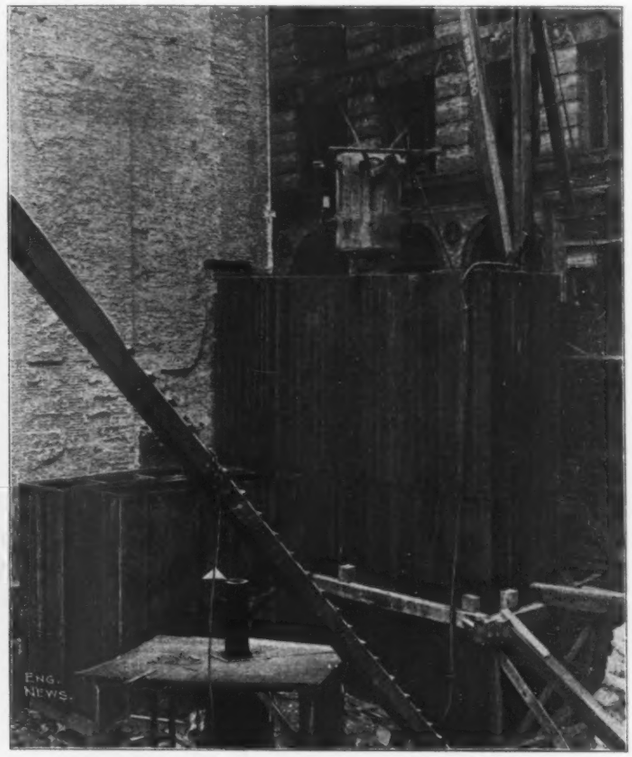


FIG. 4. CAISSON THREE SECTIONS HIGH IN PROCESS OF SINKING.

(The two adjoining caissons will be sunk close to the wall at the left.)

The concrete within the first caisson has to be intimately united with the concrete in the adjoining caissons. This is accomplished in the following manner: As the first caisson is being sunk and filled with concrete above the roof of the air chambers, iron forms are set at each end of the caisson, in such a manner as to leave open wells in the concrete adjoining the caisson ends. These half-wells are of semi-elliptical cross-section and about 4 × 5 ft. in size, the long axis being parallel with the wall. The iron forms used for making these wells are removable, wooden wedges being employed on the flat sides. Immediately under each of these wells, and in the roof of the air chamber, a semi-circular plate is bolted, 3 ft. in diameter. When the air chamber of the first caisson sunk is filled with concrete, forms are set to make a continuation of the two wells left in the concrete above the air chamber.

After this is accomplished the second caisson is sunk as close as possible to the first one, and open wells are left in the upper concrete filling, as was done in the first caisson. When the second caisson reaches the rock, and the bottom edge has been sealed, preparations are made for connecting the two adjoining air chambers. In the end timber walls of each caisson—on the line with the air chambers—two removable doors are provided in the original construction. These doors are rested against beveled seats in the caisson wall, and both of them open towards the second caisson. The bolts securing the door in the second caisson are first removed and the door is pulled into the air chamber. As this is done men stand ready with balls of clay, which are quickly thrust into the space between the two caissons, and are held there by the air pressure sealing the joint against the entrance of water. The door in the first caisson is thus exposed, and is then removed—in the same manner as the first door. Communication is thus established between the well-space left in the concrete of the first air chamber, and the air chamber of the second caisson. The adjacent walls of the two caissons are now forced together by heavy bolts, and an absolute water-tight joint is made between them by wedging—if necessary.

The filling of the well and of the second air chamber with concrete can now be commenced; the union between the old and new concrete being carefully made. When the second air chamber is filled, the 3-ft. semicircular plates in the air-chamber roof can be removed and connection is thus made with the open well above extending to the top of the caisson. The wooden ends of the caissons and the angle-iron braces within have been especially designed to facilitate the connection above described. Next, working in these wells two lines of bolts are placed, drawing the wooden end walls of the adjacent caissons close together. A water-tight joint is thus secured, and the timbers of both caissons inside these bolts can now be removed; and when the well is filled, the concrete masonry of one caisson is thoroughly united with that of the other. Of course, at the angles of the foundations, the connecting well in the concrete of one of the caissons would be located at the side instead of the end.

Fig. 5. Cylinders Being Sunk for Foundations in the Narrow Wall St. Extension of the new Stock Exchange Building.

(The undulating lines on the lower part of the photograph are made by the hats of passing pedestrians.)

Simultaneously with the sinking of the continuous caissons about the site of the building, circular caissons, also of wood, and 6 ft. 8 ins. in diameter, are being sunk to the rock in the interior of the area. Within these caissons, and at their bottom, will be placed the column footings. When the sinking of the exterior line of caissons is completed the earth in the interior will be excavated. While this work is going on, the caissons will be strongly braced to resist any inward movement from the outside pressure. With the rock bared and concreted, the columns are set and the bottom system of beams is put in place. The set of beams above the lowest is made to act as a system of struts, to permanently carry the external pressure on the caissons. Horizontal bearing beams are set against the walls of the caissons; and then by means of hydraulic jacks the struts abutting against these beams are put under an initial compression greater than that exerted upon the caissons from outside, considering them as retaining walls, and as sustaining hydrostatic pressure.

As absolute impermeability is one of the requisites of this continuous masonry caisson construction, Mr. O'Rourke has devised a means of filling up the vacancies due to the inevitable slight shrinkage of the concrete in setting. In filling the caissons and connecting the concrete masonry, the air shaft in the center of each caisson is left unfilled until a sufficient time has elapsed for the setting of the concrete, and a space is left in the surface of the air-chamber filling at the bottom of

these dredging operations, the training of the river will be begun from the south end, which will be carried northwards with the stream. In continuation of the existing banks, wherever they exist, a width of some 2,000 ft. having been left for the river, impediments of stakes and brushwood will be run out for lengths of 15 or 20 miles, and all escape channels will be barred. When the muddy waters of the Assua and other right-hand tributaries come down in flood, between May and September, the mud and silt will be caught by the stakes and brushwood and incipient banks will be begun. On these banks osiers and willows and other plants which love a water-logged soil will be planted. This work will be continued until it meets the dredges, and then progress will be more rapid.

Eventually the Cape to Cairo railway will run on these banks, and a highway will be established through the heart of Africa. The Soudan will then be to Egypt what nature meant it for, a possession of exceeding great value. No time, however, should be lost. Sir Reginald Wingate should never rest contented till he has under his orders three or four strong brigades of irrigation engineers, examining the country and preparing projects. It may take years to complete the projects; but the sooner they are begun the sooner will they be ready. Eventually the money will be found, and then the well-matured projects which have been prepared without hurry will be put in execution with method, and with success already assured. The Soudan is a poor country in itself, but as a highway for the waters of the great lakes it is of inestimable value to Egypt; and when Egypt has realized this and begun to spend her money freely on the great works contemplated in this paper, then will begin that resurrection of the Nile Valley which will be the crowning glory of the British occupation of Egypt.

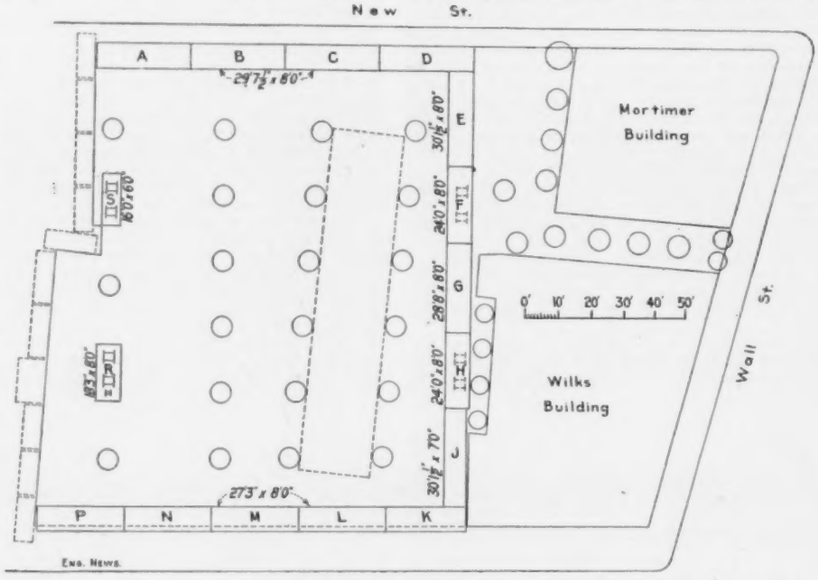


FIG. 1. GENERAL PLAN OF CONTINUOUS CAISSON FOUNDATIONS FOR THE NEW BUILDING OF THE NEW YORK STOCK EXCHANGE.

George B. Post, Architect; John F. O'Rourke, M. Am. Soc. C. E., Engineer and Contractor for Foundation Work.

WATER-TIGHT CAISSON FOUNDATIONS FOR THE NEW YORK STOCK EXCHANGE.

The plans for the new building of the New York Stock Exchange, located on Broad St., New York city, require the foundations to be carried to the rock, which is at a depth of about 60 ft. below the curb-line. The material to be penetrated is water-bearing, and is largely made up of a fine micaceous quicksand, with some clay strata. As it is proposed to utilize the whole of this basement area, practically to the rock surface, the supporting sidewalls must be impervious to water and they must make a water-tight joint, with the rock and the concrete floor covering this rock. In two cases where similar construction has been demanded for large office buildings in down town, New York, caissons have been used; sunk about 1 ft. apart on the line of the foundations, and the space between each two caissons has been packed with clay to secure a water-tight joint. But in the case of the Stock Exchange, and, for the first time, so far as we know, a continuous concrete masonry wall is being built by means of caissons sunk by the employment of compressed air.

This novel departure in caisson foundation work is the invention of Mr. John F. O'Rourke, M. Am. Soc. C. E., Consulting and Contracting Engineer, Park Row Building, New York city, and was patented by him on July 16, 1901. The method adopted may be described as follows:

The caissons used are built of wood instead of iron—of a general design covered by another patent of Mr. O'Rourke, dated Aug. 22, 1899. Each caisson is rectangular in shape, 30 ft. long and 8 ft. wide, outside measurement. The lowest, or air-chamber section, is 8 ft. high, and the chambers above it are each 15 ft. high. It might be mentioned that the latter height was due to the proposed transport of these caissons in sections across the Brooklyn bridge; but as it was later decided to lighter them across the East River, they might have been made much higher. The caisson walls are built up of vertical timbers, 4 ins. thick, strongly tied and braced together internally by angle irons; and thoroughly calked at all the seams. The sections of the caisson are connected together by a male and female angle-iron joint. The angle of the upper section slips down below the top of the lower caisson, and the two angles are bolted together like a flanged joint. The final water-tight joint is made with a rope-gasket dipped in linseed oil. The calking of this horizontal joint was experimented upon, but it was found that the gasket-joint was quite as efficient and much less troublesome.

The large caissons weigh about 15 tons each, and they are handled and set in place for sinking by powerful boom-derricks. To sling these caissons, an interior frame is employed made of 4 × 4 × ½-in. angles, and 8 ft. long by 6 ft. wide. In the four inner corners of this frame are heavy gusset-plates, slightly bent in the line of the hoisting chains, and provided with 2-in. holes for connecting two sets of 1½-in. hoisting chains, each set having its own ring. From each corner of this frame hang about 4 ft. of heavy chain, terminating in an eye-iron with a threaded end. To connect this frame with the caisson four sets of 6 × 6-in. angle irons, 4 ft. long, are securely bolted inside of the caisson and spaced so as to cover the center of gravity of the caisson. The eye-irons mentioned enter holes in these angle irons, and are secured by nuts. When the caisson has been exactly located, ready for sinking, the 6 × 6-in. angles are removed and the bolt-holes required to secure them to the caisson are carefully plugged up.

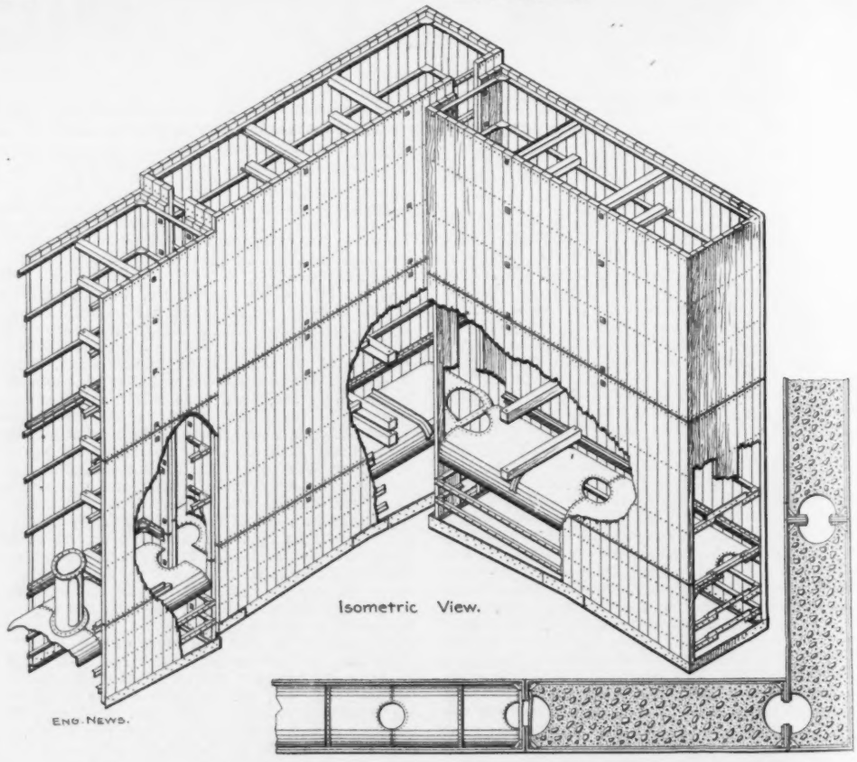
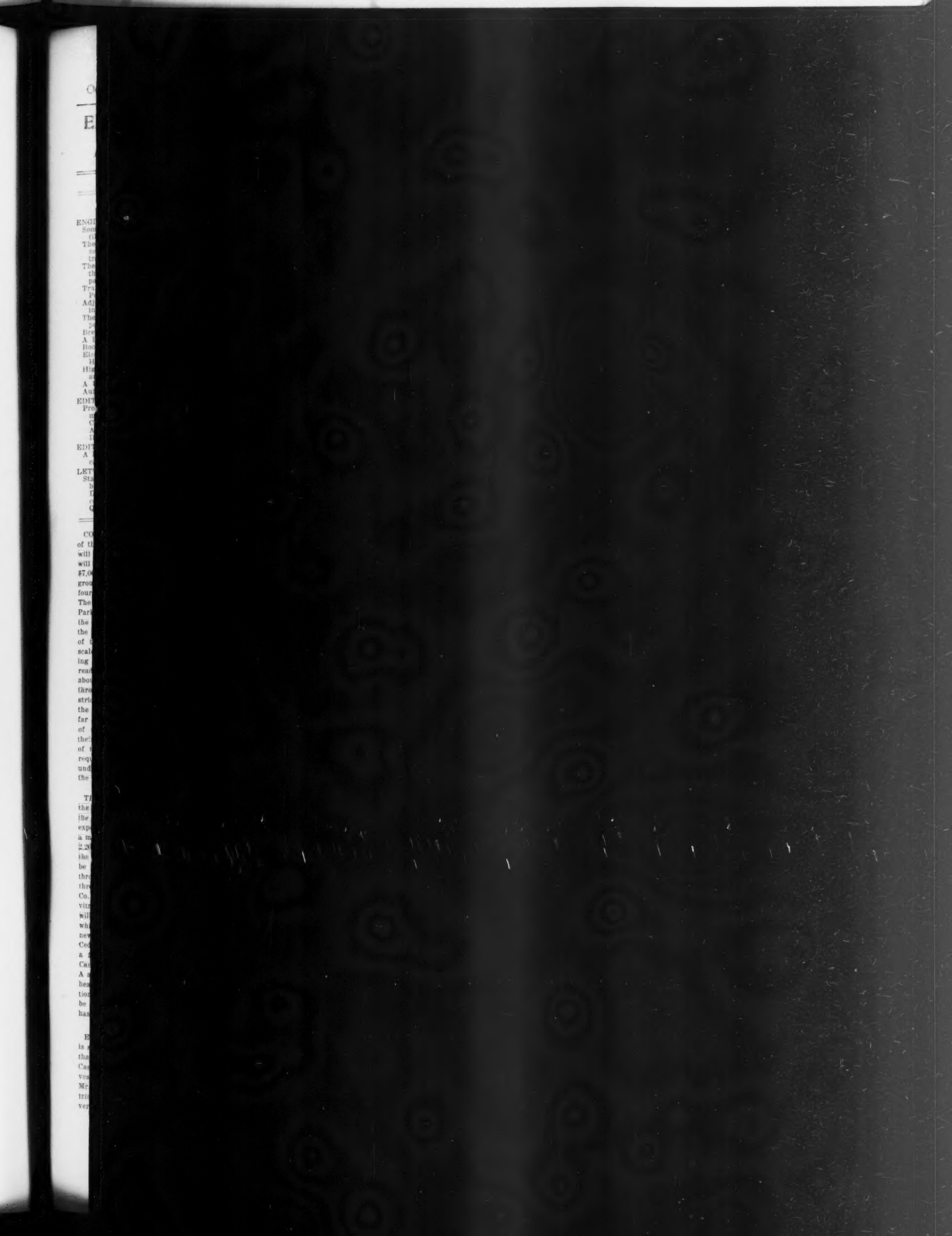


FIG. 2. ISOMETRICAL VIEW ILLUSTRATING THE PROCESS OF SINKING CONTINUOUS CAISSON FOUNDATIONS.

As these caissons are to be sunk by means of compressed air, an air chamber is provided in the bottom section by covering this section with an iron roof, which is arched in the two outside thirds of the width of the caisson, and strengthened by angle-iron ribs. The middle third is left flat to permit better connection with the working



this shaft. The air shaft is then fitted with a door at the top and connection is made for air pressure. Thin grout is next deposited at the bottom of this air shaft, the upper door is closed, and the air pressure turned on. The effect of this operation is to force the grout into all shrinkage spaces and to thoroughly seal the entire mass of masonry against percolation.

The air-chamber gang consists of eight men and a foreman. The material is shoveled into a bottom-dump bucket, 30 ins. in diameter, and 36 ins. high; and by special appliances, patented by Mr. O'Rourke, the material is hoisted out through the air lock and deposited upon the dump about

Of late, bacterial analyses have been put to good use in studying the course of the discharges from outlet sewers, notably at Boston and below Chicago, along the Des Plaines and Illinois River.

The care and discretion required in plating bacterial samples and, in short, throughout all investigations of a bacterial nature, render it desirable for the samples to be collected by a person conversant with bacterial methods, and also make it essential, if reliable results are to be obtained, to entrust the analysis to none but the most competent men.

Some remarks on reducing water ram produced by direct-acting pumps, were made by Mr. Geo. E. Winslow, of Waltham, Mass. The method employed is the use of a governor to cut off the steam before the end of the stroke. Where a pump is fitted with such a governor, a break

The committee on "Standard Specifications for Cast-Iron Pipe" submitted a preliminary report, which included a table of dimensions and weights. Specifications were also submitted, but the committee expects to change these. The full report, with amended specifications, will be printed and distributed soon, after which it will be brought up for discussion at one of the winter meetings.

One of the features of the report is a proposal to require all pipe 4 to 18 ins. in diameter to have a uniform outside diameter, regardless of thickness of shell. In other words, variations in shell thickness would deduct from or add to the internal instead of the external diameter. The committee thinks this would facilitate joint making. On pipe more than 20 ins. in diameter the variations in thickness would be distributed between the inner and outer diameters.

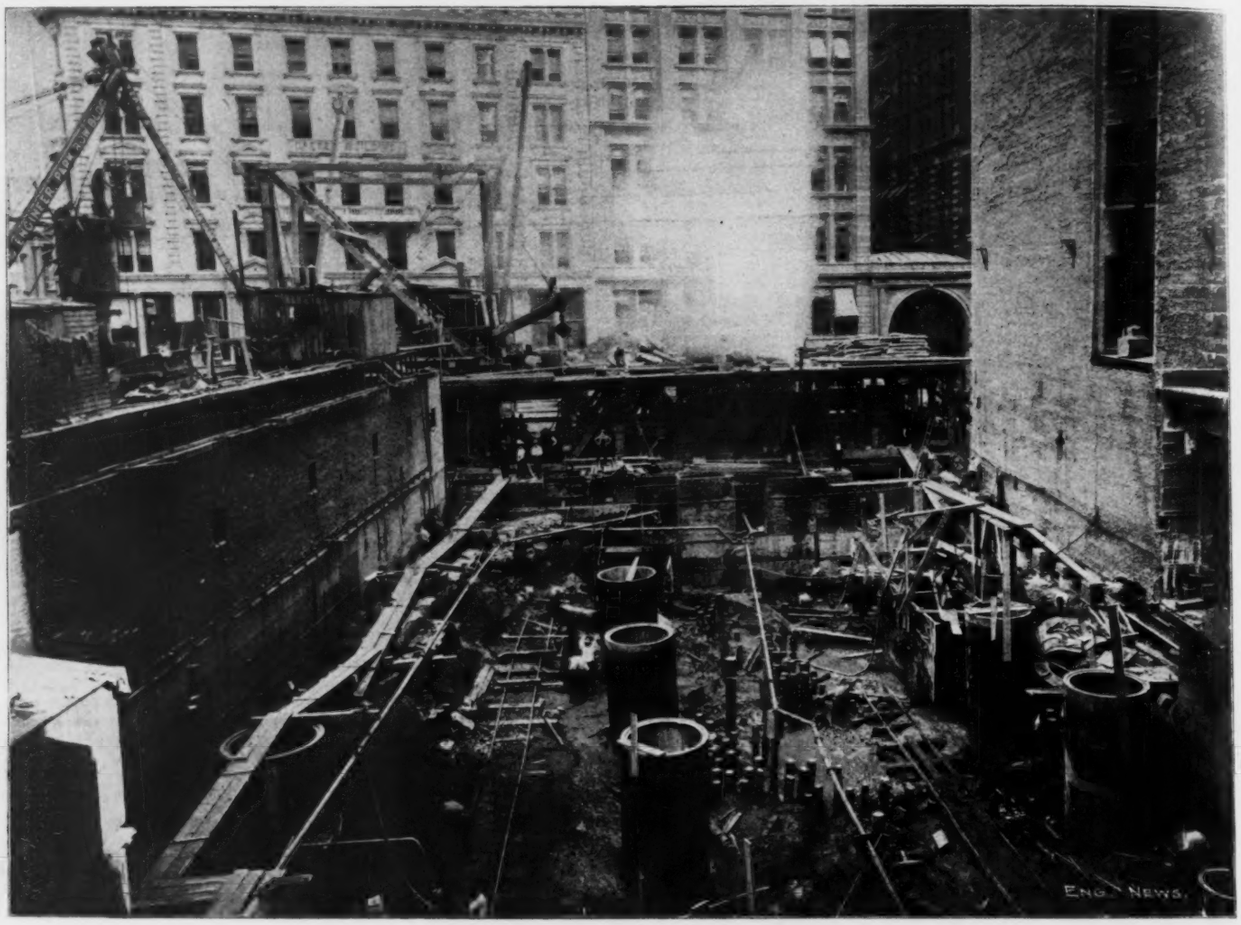


FIG. 6. CONDITION OF FOUNDATIONS FOR THE NEW YORK STOCK EXCHANGE BUILDING, SEPT. 4, 1901.
(In the rear, walls are already being built upon the caissons sunk.)

as fast as the men can shovel it into the buckets. In removing this quicksand the men average about 10 cu. yds. per hour; the maximum rate of sinking a caisson being 4½ ft. in 4 hours.

ANNUAL CONVENTION OF THE NEW ENGLAND WATER-WORKS ASSOCIATION.

The twentieth annual convention of the association was held at Portland, Me., Sept. 18 to 20. The general suspension of business Thursday, on account of the funeral of the late President McKinley, shortened very materially the time devoted to business, which accounts for the brevity of the proceedings.

The first paper was read by Mr. Chas. Edw. Amory Winslow, of the Massachusetts Institute of Technology, Boston, Mass. Its title was "Bacterial Analysis of Water and Its Interpretation." The author made clear the difficulties besetting the detection of typhoid germs in water. One after another supposed solution of this problem has been abandoned by the best bacteriologists. To-day the consensus of opinion is that no practicable method has yet been discovered for isolating this germ from water. The best proof of probable danger of typhoid infection is the determination of the colon bacillus, but this germ is found in the intestines of other animals than man. Nevertheless, a water containing many bacteria, including the colon, is rightfully considered dangerous.

in a main will merely shorten the length of the stroke and at the same time quicken it, thus avoiding ram. The discussion on this subject brought out the fact that patents or devices intended to give the same general effect are held by the Worthington and Holly companies, and by Clark, of Northampton, Mass. Mr. Winslow stated that he employed a mechanism different in principle, and that he had patented it.

A paper describing the sanitary inspection carried out in the Sudbury, Cochituate and Nashua drainage areas of the Metropolitan water-works, was read by Mr. Wm. W. Locke, Sanitary Inspector, South Framingham, Mass. The work was begun on behalf of the Boston water-works in 1870 by Mr. Desmond Fitzgerald, Past Pres. Am. Soc. C. E. A test case, a few years later, established the right of the city to prevent the pollution of its water supply. The Metropolitan Water and Sewerage Board is specifically authorized to prevent pollution and has formulated rules to that end. Cities and towns in Massachusetts outside the district may, on application, secure rules to the same end by applying to the State Board of Health.

Where pollution is found the plan followed in the Metropolitan drainage areas is to try to induce those responsible for the nuisance to abate it voluntarily. If this fails the matter is taken into court. The Supreme Court of Massachusetts has held that owners of property are responsible for pollution by tenants whenever the evil is due to appliances or facilities supplied by the owner.

Specials 18 ins. in diameter and below would all fall in one class; those above, in three classes.

In discussing this paper, Mr. Hawley, of Atlantic City, said he thought the larger sizes of pipe should be cast with a proper sink head, to prevent spongy pipe ends. He also thought that many improvements in foundry practice are needed and that they will not come unless engineers take the initiative and demand them. He favored the sand blast for cleaning pipes before coating them; thought improved methods of heating, including an accurate means of ascertaining the temperature of the casting, a necessity; and favored mineral rubber coating, if properly applied.

Mr. F. C. Coffin is chairman and Mr. Dexter Brackett, M. Am. Soc. C. E., one of the other members of the committee.

The committee on "Apportionment of Charges for Private Fire Protection and Means of Controlling the Supply Thereto" presented a report through its chairman, Mr. B. I. Cook, of Woonsocket, R. I. This report was printed and circulated a few weeks ago, and was commented on in our issue of Aug. 22. The committee asked for further time before making its final report.

On Thursday evening a banquet was tendered to the members and guests by Mr. Geo. P. Westcott, of the Portland Water Co. All day Friday was devoted to an excursion to Sebago and Long Lakes. The exhibits, which appeared to be fewer than usual, are noted in the supplement to this issue.